INTERNATIONAL BURCH UNIVERSITY

FACULTY OF ENGINEERING AND NATURAL SCIENCES

DEPARTMENT OF INFORMATION TECHNOLOGIES

THIRD CYCLE STUDY PROGRAM SPECIFICATION

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1. PROGRAM DESCRIPTION

1.1. Introduction

The advances in computer technology have added new fuel to the development of almost all of the science and engineering applications. Because of its role in the improvement of civilization, this discipline became a separate engineering profession. In today's age of information, Information Technology is one of the main branches of engineering that contribute through professional services towards more prosperous and sustainable society.

1.2. Mission

The mission of the Department of Information Technology is to educate the students to gain an understanding of the fundamentals of science and engineering so that they can develop solutions to Information Technology problems and enhance their skills on computer science, computer architecture, design and analysis of algorithms, software engineering, communication and research skills. It is aimed to especially emphasize teamwork, independent and innovative thinking and leadership qualities.

1.3. Aims of the Program

- To facilitate the provision of a quality learning experience for each student that fosters engagement with their programme of study and promotes independent study and life-long learning;
- To maintain a high quality, comprehensive and coherent computing focussed curriculum informed by research, scholarly activity and practice which enhances each participant's career prospects;
- To develop professionals with a sound understanding of computing and a critical awareness of current issues, who are able to adopt appropriate research strategies, and are informed of wider contextual issues;
- To encourage the creative and appropriate application of technology to promote innovation, enterprise and employability;
- To promote ethical awareness and professionalism supported by a strong appreciation of industry focussed skills and practice.
- To promote students' self-discipline and self-assurance and the ability to learn on their own,
- To produce graduates for the engineering and the business communities who are observant, inquisitive and open to new technologies for developing better solutions,
- To produce graduates for the engineering and business communities with integrity, determination, judgment, motivation, ability and education to assume a leadership role to meet the demanding challenges of the society.

1.4. Program

The Information Technology PhD program is based on three years doctor of philosophy Degree Program with 180 ECTS credits. The first year of the program is dedicated to the study of advanced engineering courses of computer engineering and Information technology. The Curriculum of the program includes elective courses, which give an opportunity to students to improve their academic skills according to their interests. The requirements for a PhD degree in Information Technology include the completion of minimum of 180 ECTS credits of formal course work and PhD dissertation. The PhD program of department of IT is designed to prepare students for higher-level academic positions. The topics covered in IT course work include:

- the role of information technology in global society;
- the development of Internet business sites and electronic commerce;
- the role of information systems in business and government;
- fundamentals of computer programming, data analysis and networking;
- database concepts, applications and design;

- information systems analysis, design and implementation;
- information security, information assurance and network security.

1.5. Learning and Teaching

Learning and teaching methods provide high quality learning opportunities that enable students to demonstrate achievement of the learning outcomes of the course and those of the modules which constitute their chosen route of study.

The course aims to foster the development of independent study skills and autonomy of learning and encourage a commitment to lifelong learning and continuous professional development. Teaching and learning methods increasingly promote the capacity for students to assume responsibility for their own learning and development. Progressive use of project learning, integrated assessment and product/problem based learning allow students to take on greater self-direction of their learning. Emphasis is often placed on group and team working throughout the study.

The course employs a wide range of learning opportunities and teaching methods, informed by curriculum review, pedagogic research and continuous staff development. Particular methods for each module or cohort are identified prior to delivery through the annual planning process. Innovative approaches to teaching, learning and assessment are encouraged. The course seeks to expand the application of technology in the delivery of teaching and learning support wherever appropriate.

Scheduled sessions will include the use of lectures, seminars and practical sessions. Advantage will be taken of both technology and supportive activities to ensure that effective learning takes place. These activities will include the use of simulations, role play, case studies, projects, practical work, work based learning, workshops, peer group interaction, self-managed teams and learner managed learning.

1.5.1. Teaching/learning methods and strategies

Lectures/classes: offer information, literature review and illustrative application and present and explore core ideas in the subject. A student will apply intellectual skills to prepare solutions to examples sheet questions which will be discussed in a small class.

Practical sessions: computational methods are taught as a series of computer-based practical with short introductory lectures on theory. This enables a student to understand issues in application of computational methods to simulated and real problems and also develop computing skills relevant to the rest of the course including the research project. Practical, computer-based and experimental lab based, provide an opportunity for a student to consolidate the theory they have learned about in lectures and apply it to problems.

Group project: provides an opportunity to study a real computer engineering problem in depth, practice analytic and problem-solving skills, and work in a team.

Individual project: involves a literature review, problem specification and experiments/analysis written up in a report. This enables a student to practice the application of techniques they have learned about to a technology problem in some depth as well as put into practice general research skills.

Expert (guest) lectures and seminars: provide a student with the opportunity to hear internal speakers and external speakers from industry. This enables a student to gain appreciation of some applications, needs and roles of computer engineers as well as career opportunities.

1.6. Assessment Protocols

The purpose of outcomes-based learning assessment is to improve the quality of learning and teaching in Information Technology department. The fundamental principles are:

- Student learning is the central focus of the department‘s efforts.
- Each student is unique and will express learning in a unique way.
- Students must be able to apply their learning beyond the classroom.
- Students should become effective, independent, lifelong learners as a result of their educational experience.

Assessment of the IT Learning Outcomes (ITLOs) begins with the normal assessment process in the major courses that are taken by students. Each course defines course outcomes and relates the course outcomes to the ITLOs. Students also prepare portfolios that reflect their achievements and capabilities, and the evaluation of the portfolios by a faculty committee represents the final assessment of a student‘s achievement in the ITLOs.

1.6.1. Assessment

Assessment of knowledge and understanding is by:

- Unseen written examinations
- Written essay assignments
- Assessment of practical work
- Group project report write-up and team presentation
- Individual project report and short presentation/viva

1.6.2. Grading

The final success of a student after all envisioned forms of testing is evaluated and graded through the system of comparison ECTS with the scale of grading, as follows:
a) 10 (A) – outstanding performance without errors or with minor errors, carries 95-100 points
b) 9 (B) – above average, with few errors, carries 85-94 points
c) 8 (C) – average, with notable errors, carries 75-84 points
d) 5 (F, FX) – performance does not meet minimum criteria, less than 75 points.

1.7. Learning outcomes

The PhD in Information Technology program will enable graduates to understand and articulate the different levels and aspects of information technology in the context of an enterprise. The Major Learning Outcomes for department of Information Technology are as follows:

Critical Thinking and Quantitative Reasoning in IT: IT graduates will be able to use critical thinking and quantitative processes to identify, analyze and solve problems, and evaluate solutions in an IT context.

Information Technology Application: IT graduates will be able to select existing and cutting-edge IT tools and procedures to develop modules and systems.

Information Technology Management: IT graduates will be able to assess and determine information resource requirements to develop solutions suitable for IT and business managers operating in a multinational and multicultural environment.

Information Technology Professional Practice: IT graduates will be able to work effectively in individual and group situations, understand how groups interact, be able to assume a leadership role when required, and understand the fundamentals of professional and ethical conduct.

Information Technology Systems Theory and Practice: IT graduates will be able to understand and communicate the fundamentals of systems theory in the development of appropriate systems that function in a global environment.

On successful completion, IT department master students will be able to demonstrate:

- a systematic understanding of key aspects of computing, including acquisition of coherent and detailed knowledge, at least some of which is at, or informed by, the forefront of defined aspects of a discipline
- an ability to deploy accurately established techniques of analysis and design
- a wide breadth of understanding that enables them to devise and sustain arguments and solve problems using ideas and techniques, some of which are at the forefront of computing practice, and describe and comment upon particular aspects of current research, or equivalent advanced scholarship
- an appreciation of the uncertainty, ambiguity and limits of knowledge
- consistent application of the development methods and techniques that they have learned to review, consolidate, extend upon, and to initiate and carry out projects to a professional level
- an ability to critically evaluate arguments, assumptions, abstract concepts and data, to make judgements, and to frame appropriate questions to achieve a solution – or identify a range of solutions – to a problem.

1.8. Skills and other attributes

On successful completion of master level students should be able to demonstrate they:

- have the ability to manage their own learning, and make use of scholarly review and primary sources (for example, referred research articles and/or original materials appropriate to the discipline)
- can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences
- they have the qualities and transferable skills requiring the exercise of initiative and personal responsibility, decision-making in complex and unpredictable contexts and the learning ability needed to undertake appropriate further training of a professional or equivalent nature

1.8.1. Intellectual skills

By the end of the course a student will have developed skills in:

- Synthesis: integrate theory and practice, and devise appropriate theoretical models of computer engineering systems.
- Computational analysis: select and apply appropriate computational techniques to solve a given problem
- Experimental analysis: acquire, analyse and interpret synthetic and experimental data and understand the strengths and limitation of using each type of experimental data analysis.
- Critical analysis: read, critique and discuss scientific articles, especially those that cross discipline boundaries between engineering and other fields. Present a written argument based on reading from a variety of sources.
- Problem solving: apply engineering principles to solve different problems.
- Evaluation: interpret experimental data scientifically and demonstrate skills necessary to plan, conduct and report on a research project

1.8.2. Discipline-specific practical skills

By the end of the course a student will be expected to have practical skills to enable them to:

- Select and apply appropriate computational methods to solve different engineering problems.

- Use information technology for the collection and analysis of experimental data.
- Undertake a research project independently and with minimal supervision/guidance.
- Understand issues in and have gained experience in working in multi-disciplinary teams.

1.8.3. Transferable skills

By the end of the course a student will have developed a range of transferable skills including skills in:

- Managing their own learning and conducting independent thinking and study
- Problem specification and modelling
- Applying mathematical and computational methods to solve (engineering) problems
- Use of general information technology
- Managing a research project, including planning and time management
- Conducting an engineering-based research-based work, from hypothesis to report writing
- Working in a multi-disciplinary team
- Critical analysis

1.9. Methods for Evaluating and Improving the Quality and Standards of Teaching and Learning

- Student Focus groups and the annual student survey
- Class room observation of Lecturers
- Advanced Professional Diploma in Teaching and Learning in Higher Education
- Membership of the Higher Education Academy
- External Examiners reports
- Accreditation Visits
- Curriculum Area Review
- Course Committees
- Annual and periodic review

1.9.1. Mechanisms for gaining student feedback on teaching quality and their learning experience

Questionnaires collected for each component of the course and considered by the course director/tutors in a department meeting and acted on as appropriate. Termly individual meetings between students and the Course Director. Self-assessment progress reports completed by students at the end of each term.

1.9.2. Mechanisms for the review and evaluation of teaching, learning, assessment, the curriculum and outcome standards

Departmental meeting in June/July at which course tutors consider current course structure, delivery arrangements, student performance in assessment, and student feedback and make recommendations for change and improvement. Also used to help spread best practice for teaching and learning techniques. Examiners reports (both internal and external) on the examinations in a particular year, commenting on pass rates, standards of learning and examination performance. Teaching evaluation questionnaires.
Annual Course Director Report to the Department Academic Committee with details on admissions, staffing, course changes and feedback, student performance, destination of graduated MSc students, and any difficulties encountered on the course. Student destination, whether employment or further study. An Advisory Board (from industry and clinical practice) providing occasional and valuable comments on the progress and development of the course from their respective perspectives.

1.10. Indicators of Quality and Standards

- Student feedback
- Retention and success rates for each level for each course
- Student Module Evaluations
- Annual Student Questionnaires
- First Destination Statistics
- Professional accreditation
- External Examiner reports

1.11. Criteria for Admission

The admissions policy for overall Scheme, in which the Computing course operates, is to admit any applicant who is capable of benefiting from and successfully completing their chosen course. Where selection criteria are devised they will be tuned to satisfy the widening participation agenda and equal opportunity policy of the University. Admissions profiles will be reviewed annually as will selection criteria and will provide a fair and objective basis for selection to oversubscribed courses. Admission with advanced standing will follow University Procedures. Applications will normally be considered in the light of a candidate's ability to meet the following criteria:

1.11.1. Academic ability

1) The applicant has provided appropriate indications of proven and potential academic excellence. Appropriate indicators include two or more confidential references, academic transcripts or their equivalent, (on the application form) a statement outlining how the course will help progress the applicant's career, and performance at interview.
2) The applicant has provided sufficient evidence, in the view of the assessor, to suggest that they have the academic ability and commitment to pursue the chosen programme to a successful conclusion within the required time limits. This includes; a sufficient level of mathematics and/or computer programming completed on the first degree or otherwise as a foundation for successful completion of the course; an understanding of how the MSc will help the applicant progress their career, and evidence of the ability (prior experience or potential) to work in a multi-disciplinary team.
3) Applicants are normally expected to have achieved an Honours Degree (or equivalent) in engineering, physical sciences, mathematics, computer science subject, or a related subject.

1.11.2. English Language Requirement

Applicants whose first language is not English are required to provide evidence of proficiency in English. Candidates are normally expected to meet the following criteria:
For IELTS an overall score of 5 For TOEFL an overall score of 450, or for the computer-based test, an overall score of 200 or equivalent score.

1.11.3. Suitability

1) The programme of study that the applicant wishes to pursue is well suited to the academic interests and abilities to which they have drawn attention in their application and (where appropriate) the applicant has undertaken any preliminary academic work or course which is normally considered indispensable to acceptance on the proposed programme of study.
2) The Department of IT is able to provide appropriate supervision and facilities for the candidate's chosen programme of work

2. CURRICULUM OF DEPARTMENT OF INFORMATION TECHNOLOGY

1. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
XXXxxx	Elective I	3	0	6
XXXxxx	Elective II	3	0	6
XXXxxx	Elective III	3	0	6
XXXxxx	Elective IV	3	0	6
CEN 692	Seminar I	0	3	6
	Total	**12**	**3**	**30**

2. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
XXXxxx	Elective V	3	0	6
XXXxxx	Elective VI	3	0	6
XXXxxx	Elective VII	3	0	6
XXXxxx	Elective VIII	3	0	6
CEN 693	Seminar II	0	3	6
	Total	**12**	**3**	**30**

3. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
CEN 695	PhD Dissertation I	0	0	30
	Total	**0**	**0**	**30**

4. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
CEN 696	PhD Dissertation II	0	0	30
	Total	**0**	**0**	**30**

5. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
CEN 697	PhD Dissertation III	0	0	30
	Total	**0**	**0**	**30**

6. Semester				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
CEN 698	PhD Dissertation IV	0	0	30
	Total	**0**	**0**	**30**

COURSES				
CODE	**COURSE NAME**	**T**	**P**	**ECTS**
CEN 621	Cryptography and Network Security	3	0	6
CEN 622	Information Security	3	0	6
CEN 624	Distributed Database Systems	3	0	6
CEN 628	Parallel Programming Languages-Systems	3	0	6
CEN 633	Advanced Database Systems	3	0	6
CEN 640	Advanced Operating Systems	3	0	6
CEN 645	Robot Motion Control and Planning	3	0	6
CEN 652	Business Intelligence	3	0	6
CEN 654	Aspect-Oriented Software Development	3	0	6
CEN 657	Application of Computer Graphics	3	0	6
CEN 659	Computational Intelligence	3	0	6
CEN 661	Special Topics in Decision Support Systems	3	0	6
CEN 662	Natural Lang. Processing	3	0	6
CEN 664	Philosophical Foundations of Artificial Intelligence	3	0	6
CEN 665	Data Communications and Computer Networks	3	0	6
CEN 667	IT Governance	3	0	6
CEN 669	Special Topics in Machine Learning	3	0	6
CEN 670	Special Topics in Data Mining	3	0	6
CEN 671	Special Topics in Pattern Recognition	3	0	6
CEN 673	Special Topics in Bioinformatics	3	0	6
CEN 682	Special Topics in Computer and Network Security	3	0	6
CEN 691	Fuzzy Systems and Control	3	0	6
CEN 692	Seminar I	0	3	6
CEN 693	Seminar II	0	3	6
CEN 695	PhD Dissertation I	0	0	30
CEN 696	PhD Dissertation II	0	0	30
CEN 697	PhD Dissertation III	0	0	30
CEN 698	PhD Dissertation IV	0	0	30
EEE 631	Stochastic Signals and Systems I	3	0	6
EEE 632	Stochastic Signals and Systems II	3	0	6
MAN 608	Advanced Statistic	3	0	6
MAN 617	Forecasting Techniques	3	0	6
MAN 629	Qualitative Research Methods	3	0	6
MAN 630	Quantitative Research Methods	3	0	6

Course Code: CEN 621	**Course Name:** CRYPTOGRAPHY AND NETWORK SECURITY		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	Fundamental concepts of cryptography, block ciphers, stream ciphers, cryptographic hash functions, public key encryption, digital signatures, key distribution protocols and other topics in cryptography. Additionally, essentials of error-correcting codes will be introduced.		
Course Objectives	Objective of this course is to give students understanding of the principles of encryption algorithms both classical and public key cryptography as well as encoding for error correcting codes.		
Course Content	• Introduction to Coding Theory and Cryptography • Linear Codes • Perfect Codes and Hamming Codes • Symmetric-key cryptography (1) • Symmetric-key cryptography (2) • Public-key cryptography • Elementary Number Theory for RSA	• Homework discussion • RSA cryptosystem • Digital Signatures • Authentication Protocols • Secret Sharing Schemes • Zero Knowledge Proofs • Key Exchange Protocols • Presentations	
Teaching Methods Description	• Interactive Lectures and hand-on activities • Writing Projects	• Computer Implementation • Article Presentations	

Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	20 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	20 %	Final Project	30 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Demonstrate an understanding of classical cryptosystems 2. Demonstrate an understanding of public-key cryptosystems 3. Demonstrate an understanding of mathematical tools used in cryptography 4. Implement certain cryptographic algorithms 5. Demonstrate an understanding of basic principles of coding theory 6. Demonstrate an understanding of mathematical tools used in coding theory 7. Explain the difference between coding theory and cryptography.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Coding Theory and Cryptography: The Essentials, Second Edition, 2nd ed, Hankerson et al., Chapman & Hall/CRC, 2000 • An Introduction to CodingTheory via Hamming Codes, N. Aydin, IBU Publications, 2015. • Public Key Cryptography and the RSA Cryptosystem, N. Aydin, IBU Publications, 2015.
Recommended Literature	• Introduction to Cryptography with Coding Theory, 2nd ed, W. Trappe & L. Washington, Pearson, 2006. • Cryptography and Network Security, 6th ed, W. Stallings, Pearson, 2014.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	5	5
Preparation for Final Examination	1	10	10
Assignment / Homework / Project	1	30	30
Seminar / Presentation	2	30	60
Total Workload			154
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 622	**Course Name:** INFORMATION SECURITY		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45

Course Description	Information security is dedicated to keeping information safe from harm. This encompasses computer security, but also communications security, operations security, and physical security. The technical content of the course gives a broad overview of essential concepts and methods for providing and evaluating security in information processing systems (operating systems and applications, networks, protocols, and so on). In addition to its technical content, the course touches on the importance of management and administration, the place information security holds in overall business risk, social issues such as individual privacy, and the role of public policy. The course will be organized around a few broad themes: • Foundations: security mindset, essential concepts (policy, CIA, etc.) • Software security: vulnerabilities and protections, malware, program analysis • Practical cryptography: encryption, authentication, hashing, symmetric and asymmetric crypto • Networks: wired and wireless networks, protocols, attacks and countermeasures Applications and special topics: databases, web apps, privacy and anonymity, voting, public policy
Course Objectives	The main goal of this course is to provide you with a background, foundation, and insight into the many dimensions of information security. This knowledge will serve as basis for further deeper study into selected areas of the field, or as an important component in your further studies and involvement in computing as a whole. The primary objectives of the course are to help you: • Understand information security's importance in our increasingly computer-driven world. • Master the key concepts of information security and how they "work." • Develop a "security mindset:" learn how to critically analyze situations of computer and network usage from a security perspective, identifying the salient issues, viewpoints, and trade-offs. As a part of your general education, the course will also help you learn to: • Clearly and coherently communicate (both verbally and in writing) about complex technical topics. • Work and interact collaboratively in groups to examine, understand and explain key aspects of information security.
Course Content	• Introduction to Information Security • Metrics for Information Security • Networking and Cryptography (1) • Networking and Cryptography (2) • Information Security Planning and Deployment (1) • Information Security Planning and Deployment (2) • Vulnerabilities and Protection (1) • Vulnerabilities and Protection (2) • Identity and Trust Technologies (1) • Identity and Trust Technologies (2) • Verification and Evaluation (1) • Verification and Evaluation (2) • Incident Response (1) • Human Factors • Legal, Ethical, and Social Implications
Teaching Methods Description	• Interactive lectures and communications with students

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	100 %
	Project	0 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Describe threats to information security 2. Identify methods, tools and techniques for combating these threats 3. Identify types of attacks and problems that occur when systems are not properly protected 4. Explain integral parts of overall good information security practices 5. Identify and discuss issues related to access control 6. Describe the need for and development of information security policies, and identify guidelines and models for writing policies 7. Describe the types of contingency plan and the steps involved in developing each 8. Identify security issues related to personnel decisions, and qualifications of security personel
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• M. Merkow and J. Breithaupt, Information Security, Pearson,2006.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)			
Final Examination (1 week)			

Preparation for Midterm Examination			
Preparation for Final Examination			
Assignment / Homework / Project			
Seminar / Presentation	1		105
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 624	**Course Name:** DISTRIBUTED DATABASE SYSTEMS		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course covers following: database distribution architectures; distributed query processing; distributed query optimization; distributed transaction management; distributed concurrency control; distributed reliability protocols; multidatabase systems; mobile distributed database management.		
Course Objectives	The objective of this course is to build on the previous background of database systems by deepening the understanding of the theoretical and practical aspects of the database technologies, showing the need for distributed database technology to tackle deficiencies of the centralised database systems, introducing the concepts and techniques of distributed database including principles, architectures, design, implementation and major domain of application.		
Course Content (weekly plan)	• Introduction • Distributed Database System design (1) • Distributed Database System design (2) • Distributed Database System query languages (1) • Distributed Database System query languages (2) • Distributed Database Systems application design (1) • Distributed Database Systems application design (2) • Midterm Exam		• Storage and file structure for distributed database systems (1) • Storage and file structure for distributed database systems (2) • 1indexing for Distributed Database Systems • Distributed transactions (1) • Distributed transactions (2) • Concurrency • Recovery
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completing the course, students will be able to: 1. Describe efficiency of distributed systems. 2. Analyze related published papers. 3. Demonstrate data replication. 4. Analyze the advantages of systems. 5. Evaluate related algorithms.
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	• Tamer Ozsu, M. and Valduriez, P. Principles of Distributed Database Systems, (2nd Edition) Prentice Hall International Inc. 1999 ISBN 0-13-607938-5
Recommended Literature	• Oefali, R., Harkey Dan and Edwards, J. The essential Distributed Objects-Survival guide. John Wiley & Sons, Inc. 1996 ISBN 0-471-12993-3

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			0
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 628	**Course Name:** PARALLEL PROGRAMMING LANGUAGES-SYSTEMS		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course covers parallel programming models, languages and environments. It also covers some fundamental concepts: memory hierarchy, communication, locality, latency, synchronization, load balancing; parallel programming models: data parallel, shared address space, message passing, data-driven, object oriented, functional; parallel programming languages and runtime systems: data parallel languages, message passing libraries and language constructs, data-driven object based languages, shared memory programming, multithreading.		
Course Objectives	Objectives of this course are to: describe generic issues (as discussed in the syllabus), which must be addressed by any parallel programming system; explain, given a description of a previously unseen parallel application, where specific instances of the generic issues will arise; explain, in considerable detail, the ways in which the generic issues are addressed by the MPI and Pthreads programming models and their supporting infrastructure; apply their practical experience with MPI and Pthreads to write clean, adaptable and scalable parallel programs for simple applications; compare the approaches proposed by a range of more speculative programming models; review and critically evaluate literature describing new parallel programming models.		
Course Content	• Concurrent programming concepts; overview of course • Techniques for parallelizing programs • Synchronization, atomic actions, await statements; Pthreads library and MPD language • Formal semantics; avoiding interference; properties • Critical sections: spin locks; efficient locks; fair solutions; Parallel programming; bag of tasks paradigm • Semaphores: basic concepts and uses; the method of passing the baton; scheduling; use in Pthreads • Parallel scientific computing; grid computations • Midterm Exam		• Barrier synchronization • Monitors: basic concepts; synchronization techniques; Multiprocessor implementations • Message passing: basic concepts and examples; clients and servers; interacting peers • Message passing in Java, MPD, and MPI; Remote operations: RPC and rendezvous • Examples of RPC and rendezvous; Java RMI; implementation of RMI • Programming distributed systems • Distributed parallel programming; Heartbeat and pipeline algorithms
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completing the course, students will be able to: 1. Describe generic issues (as discussed in the syllabus) which must be addressed by any parallel programming system. 2. Explain, given a description of a previously unseen parallel application, where specific instances of the generic issues will arise. 3. Explain, in considerable detail, the ways in which the generic issues are addressed by the MPI and Pthreads programming models and their supporting infrastructure. 4. Apply their practical experience with MPI and Pthreads to write clean, adaptable and scalable parallel programs for simple applications. 5. Compare the approaches proposed by a range of more speculative programming models.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• G.R. Andrews, Foundations of Multithreaded, Parallel and Distributed Programming
Recommended Literature	• B. Wilkinson, M.Allen, Parallel Programming, Techniques and Applications'

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			0
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 633	**Course Name:** ADVANCED DATABASE SYSTEMS		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course covers following: serializability theory; locking, timestamp-ordering, optimistic schedulers; multiversion and distributed concurrency control; distributed atomic commitment protocols; multidatabase systems; active database systems; real-time database systems; object-oriented database systems.		
Course Objectives	Objective of this course is to introduce students to basic issues in object–oriented data models, learn about the Web–DBMS integration technology and XML for internet database applications, familiarize with the data–warehousing and data mining techniques and other advanced topics, and apply the knowledge acquired to solve simple problems.		
Course Content	• The Extended Entity Relationship Model and Object Model • Object–Oriented databases and Object–Oriented concepts • Object structure and type constructors\ • OODBMS architecture and storage issues • Transactions and concurrency control • Object Relational and Extended Relational Databases • Architectures for parallel databases	• Midterm Exam • Distributed database concepts; data fragmentation • Replication and allocation techniques for distributed database design • Query processing in distributed databases • Concurrency control and recovery in distributed databases • An overview of client–server architecture • Databases on the Web and Semi–Structured Data • Enhanced Data Models for Advanced Applications	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	10 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completing the course, students will be able to: 1. Explain and evaluate the fundamental theories and requirements that influence the design of modern database systems. 2. Assess and apply database functions and packages suitable for enterprise database development and database management. 3. Critically evaluate alternative designs and architectures for databases and data warehouses. 4. Discuss and evaluate methods of storing, managing and interrogating complex data. 5. Explain and critically evaluate database solutions for data exchange. 6. Analyze the background processes involved in queries and transactions, and explain how these impact on database operation and design.
Prerequisite Course(s)	None
Language of Instruction	English
Mandatory Literature	• Elmasri and Navathe, Fundamentals of Database Systems
Recommended Literature	• Ramakrishnan and Gehrke, Database Management Systems

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	35	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			0
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 640	**Course Name:** ADVANCED OPERATING SYSTEMS		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	Advanced Operating Systems is a graduate level course that covers in detail many advanced topics in operating system design and implementation. It starts with topics such as operating systems structuring, multithreading and synchronization and then moves on to systems issues in parallel and distributed computing systems.		
Course Objectives	Objective of this course is to teach students role of operating systems; how operating systems are implementer and the implications of resulting design choices. Moreover, to develop practical skills needed to understand and modify operating system code, feel competent to do so, and understand why it matters.		
Course Content	• Introduction; Memory Addressing • Processes; Interrupts and Exceptions • Kernel Synchronization • Timing Measurements; Process Scheduling • Memory Management • Process Address Space • System Calls • Midterm Exam	• Signals; The Virtual Filesystem • I/O Architecture and Block Device Drivers • The Page Cache; Accessing Files • Page Frame Reclaiming • The Ext2 and Ext3 Filesystems • Process Communication • Program ExZecution	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	10 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completing the course, students will be able to: 1. Study and explore the internals of different types of operating system. 2. Identify bottlenecks lie in the different types of operating systems. 3. Recognize the differences between various types of operating systems. 4. Perform comparisons between (algorithms, methods, techniques...etc.). 5. Specify, design, and implement some components of distributed operating systems. 6. Evaluate operating systems in terms of general quality attributes and possible trade-offs.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Bovet and Cesati, "Understanding the Linux Kernel", 3rd edition, 2005, O'Reilly
Recommended Literature	• Jain, "The Art of Computer Systems Performance Analysis", 1991, Wiley.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			0
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 645	**Course Name:** ROBOT MOTION CONTROL AND PLANNING		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course covers basic concepts of motion planning, representations of state and movement, potential functions, roadmaps, cell decompositions, robot dynamics, basic control, constrained motion, hybrid planning and control, logical reasoning methods for planning.		
Course Objectives	Objective of this course is to give students understanding of: sensing modalities and uncertainty in planning and control algorithms; development of representations and motion strategies capable of incorporating feedback signals; motion subject to constraints, arising from kinematics, dynamics, and nonholonomic systems; addressing the characteristics of dynamic environments; developing control and planning algorithms for hybrid systems; complexity of algorithmic problems in control and motion planning; application of planning algorithms in novel application areas.		
Course Content	• Kinematics (1) • Kinematics (2) • Jacobian (1) • Jacobian (2) • Dynamics (1) • Dynamics (2) • Manipulator Control	• Midterm Exam • Mobot: Mobile Robot (1) • Mobot: Mobile Robot (2) • Robot Sensing & Sensors (1) • Robot Sensing & Sensors (2) • Motion Planning • Mapping • Project presentations	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completing the course, students will be able to: 1. Model the motion of robotic systems in terms of kinematics and dynamics. 2. Analyze and evaluate a few major techniques for feedback control, motion planning and computer vision as applied to robotics. 3. Translate a subset of standard algorithms for motion planning, localization and computer vision into practical implementations. 4. Implement and evaluate a working, full robotic system involving elements of control, planning, localization and vision. 5. Develop control and planning algorithms for hybrid systems.
Prerequisite Course(s) +	-
Language of Instruction	English
Mandatory Literature	• Robotics Control, Sensing, Vision and Intelligence, K. S. Fu, R. C. Gonzalez, C. S. G. Lee, McGraw-Hill, 1987, ISBN 0-07-022625-3
Recommended Literature	• Introduction to Autonomous Mobile Robots, Roland Siegwart, Illah R. Nourbakhsh, The MIT Press, 2004, ISBN 0-262-19502-X. • Introduction to AI Robotics, Robin R. Murphy, The MIT Press, 2000

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			0
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 652	**Course Name:** BUSINESS INTELLIGENCE		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This subject introduces students to concepts and models of BI and the current state of BI research. It exposes students to research process and different approaches used in studying BI. It aims to equip research students with the skills to guide them through the key steps in designing, conducting and analyzing research in BI. , analyzing data and theory buiding.		
Course Objectives	The overall objective of this course is to introduce students to the basic concepts and techniques of business intelligence/ business analytics. Topics covered include business decision-making, evidence-based management, data warehouse design and implementation, data sourcing and quality, on-line analytical processing (OLAP), dashboards and data mining classification, regression and time series, case studies of business analytics practice.		
Course Content	• Data-Analytic Thinking • Business Problems and Data Science Solutions • Introduction to Predictive Modelling • Fitting a Model to Data • Overfitting and its Avoidance • Similarity, Neighbors and Clusters • Assignment discussion		• Decision Analytic Thinking I • Visualizing Model Performance • Evidence and Probabilities • Representing and Mining Text • Decision Analytic Thinking II • Other Data Science Task and Techniques • Data Science and Business Strategy • Project presentations
Teaching Methods Description	• Interactive lectures • Tutorial		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	30 %	Term Paper	30 %
	Project	30 %	Attendance	10 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Use BI systems and technology to support decision making. 2. Design and build BI applications based on users' needs. 3. Identify business and technical requirements for a BI solution. 4. Apply relevant theories, concepts and techniques to solve real-world BI problems. 5. Perform data analyses. 6. Visualize the results of data analyses.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Data Science for Business: What you need to know about data mining and data-analytics thinking, BY Foster Provost & Tom Fawcett, 2013.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	15		
Midterm Examination (1 week)			
Final Examination (1 week)			
Preparation for Midterm Examination			
Preparation for Final Examination			
Assignment / Homework / Project	5	21	105
Seminar / Presentation			0
Total Workload			150
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 654	**Course Name:** ASPECT-ORIENTED SOFTWARE DEVELOPMENT		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	Aspect-oriented software development (AOSD) is an advanced technology for separation of concerns, which provides explicit concepts to modularize concerns that tend to be more systemic, crosscut a broader set of modules and as such cannot be easily specified in single modules. This course will provide an in-depth analysis of the basic concepts of AOSD and teach the state -of-the-art AOSD techniques.		
Course Objectives	Objectives of this course is to teach students to use UML and design patterns to model medium-sized software systems; read and write precise invariants and pre/post-conditions of software systems using OCL; form informed opinions about advanced topics including pattern specifications, model-driven software development (MDSD), and aspect-oriented software development (AOSD).		
Course Content	• An introduction to literature review and analysis • Advanced UML modelling which includes modelling techniques using OCL, profiles, templates (1) • Advanced UML modelling which includes modelling techniques using OCL, profiles, templates (2) • Software engineering fundamentals including some core topics (1) • Software engineering fundamentals including some core topics (2) • Metamodeling (1) • Metamodeling (2)	• Midterm Exam • Pattern specifications (1) • Pattern specifications (2) • Software engineering for security (1) • Software engineering for security (2) • Aspect-oriented software development • Model-driven software development, software factories, generative programming, etc. • Project presentations	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	10 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completing the course, students will be able to: 1. Use UML diagrams for modelling and code generation. 2. Use tools for code generation from UML diagrams. 3. Define the concepts of Model Driven Architecture. 4. Define the concepts of Aspect Oriented Programming (AOP). 5. Apply the aspect-oriented paradigm and the adaptive object-oriented paradigm to problems solving, including the implementation of a project.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• MDA Explained. The Model Driven Architecture: Practice and Promise, by Anneke Kleppe, Jos Warmer, Wim Bast, Addison Wesley, ISBN: 032119442X
Recommended Literature	• Object Constraint Language, The: Getting Your Models Ready for MDA, by Jos Warmer et al., second edition, Addison Wesley, ISBN: 0321179366

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			0
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 657	**Course Name:** APPLICATION OF COMPUTER GRAPHICS		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	Computer graphics is a science which is applicable in various engineering fields. Three dimensional modelling and representation. Colour, shading and lighting methods. Representation of surfaces. Graphical databases, graphics standards. Hidden surface problem, motion and animation. Texture mapping, controlled deformations.		
Course Objectives	Objectives of this course are: explaining the basic function of the human eye and how this impinges on resolution, quantisation, and colour representation for digital images; describing a number of colour spaces and their relative merits; explaining the workings of cathode ray tubes, liquid crystal displays, and laser printers; describing and explain following algorithms: Bresenham's line drawing, mid-point line drawing, mid-point circle drawing, Bezier cubic drawing, Douglas and Pucker's line chain simplification, Cohen-Sutherland line clipping, scanline polygon fill, etc.		
Course Content	• Introduction to graphics applications • Graphics display devices and program structure • Drawing lines and simple curves • Line clipping and introduction to polygons • Polygon clipping and rasterization • Assignment discussion • Geometric transformations • Midterm Exam	• Projections and viewing • Hidden surface removal • Object definition techniques • Lighting and shading • Texture mapping • Efficiency. Further steps towards visual realism • Project presentations	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions	• Group works	

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	20 %	Term Paper	0 %
	Project	20 %	Attendance	0 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Use matrices and homogeneous coordinates to represent and perform 2D and 3D transformations. 2. Project 2D and 3D images. 3. Explain how to use filters, point processing, and arithmetic operations in image processing and describe a number of examples of the use of each. 4. Explain how halftoning, ordered dither, and error diffusion work. 5. Explain image compression and the workings of a number of compression techniques.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Computer graphics: principles and practice. Addison-Wesley (2nd ed.) by Foley, J.D., van Dam, A., Feiner, S.K. & Hughes, J.F. (1990).
Recommended Literature	• Digital image processing. Addison-Wesley by Gonzalez, R.C. & Woods, R.E. (1992). • Computer graphics and virtual environments: from realism to real-time. Addison-Wesley by Slater, M., Steed, A. & Chrysanthou, Y. (2002).

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	0	0	
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	40	40
Seminar / Presentation			0
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 659	**Course Name:** COMPUTATIONAL INTELLIGENCE		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45

Course Description	*Computational intelligence*, also known as a part of "*soft computation*" is a relatively new area of research, and is becoming more and more important in many engineering and non-engineering disciplines including control engineering. Computational Intelligence is a collection of the possible computational tools to solve the above problems in control engineering. This course will equip the student with the essential knowledge and useful resources to solve some of the systems control problems not easily solved using previously learned conventional control methods.
Course Objectives	Objective of this course is to introduce concepts, models, algorithms, and tools for development of intelligent systems. Example topics include artificial neural networks, genetic algorithms, fuzzy systems, swarm intelligence, ant colony optimization, artificial life, and hybridizations of the above techniques. This domain is called Computational Intelligence, and it is a numerical interpretation of biological intelligence.
Course Content	• Evolutionary Computation • Genetic Algorithms, Evolutionary Strategies, • Evolutionary Programming • Particle Swarm Optimization • Ant Colony Optimization • Artificial Immune Systems • Simulated Annealing and Tabu Search • Midterm Exam • Harmony Search, Honey-Bee Optimization • Memetic Algorithms, Co-Evolution, Multi-Objective Optimization, Artificial Life • Constraint Handling • Neural Networks • Fuzzy Logic • Hybrid Techniques • Research Papers Reading
Teaching Methods Description	• Interactive lectures and communications with students • Discussions • Group works

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	40 %
	Project	0 %	Attendance	0 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Describe the fundamental concepts of Computational Intelligence models. 2. Develop an independence of thought, an intellectual curiosity and a critical approach to evidence, theories and concepts in a research led environment. 3. Implement neural networks, genetic algorithms, fuzzy neural networks, and ant colony optimization algorithms. 4. Apply Computational Intelligence techniques to classification, pattern recognition, prediction, rule extraction, and optimization problems. 5. Use CI approaches in practical applications in mathematics, informatics, technology, economics, finance and other.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• A. P. Engelbrecht, Computational Intelligence, John Wiley & Sons Ltd, 2007.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 661	**Course Name:** SPECIAL TOPICS IN DECISION SUPPORT SYSTEMS		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This subject considers the intellectual foundations of the DSS field and the current state of DSS research. It exposes students to research process and different approaches used in studying DSS. In general, decision support systems are utilized by people who are skilled in their jobs and who need to be assisted rather than substituted by a computer system. In other words, the cognitive element needed to understand and derive practical, realistic and implementable action-plans from the results generated by the IT-based analytical models is just as important as the ability to design and operate these systems.		
Course Objectives	Objectives of this course are to equip research students with the skills to guide them through the key steps in developing their DSS research strategies and research proposals.		
Course Content	• Course Introduction • Typical DSS research article format • Intellectual foundations of DSS-research and theory • Current state of DSS research - literature review • DSS research planning, design and writing a research proposal • Experimental study of DSS • Survey-based study of DSS	• Assignment discussion • DSS case study • Focus groups in DSS research • Project presentations • Archival and historical research in DSS • Action and design research in DSS • Ethics in DSS research • Students' Research Proposals Presentations	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions	• Group works	

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	20 %	Term Paper	40 %
	Project	30 %	Attendance	10 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Review and clarify the fundamental terms, concepts and theories associated with Decision Support Systems, computerized decision aids, expert systems, group support systems and executive information systems. 2. Examine examples and case studies documenting computer support for organizational decision making, and various planning, analysis and control tasks. 3. Discuss and develop skills in the analysis, design and implementation of computerized Decision Support Systems. 4. Discuss organizational and social implications of Decision Support Systems. 5. Discuss ethics in DSS research.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Selected readings (TBA) Useful Web Links: • IFIP WG8.3 http://www.ifip-dss.org/ • Data Resources http://dssresources.com • Teradata University Network http://www.teradata.com
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 662	**Course Name:** NATURAL LANGUAGE PROCESSING		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	Natural Language Processing addresses fundamental questions at the intersection of human languages and computer science. In this interdisciplinary introductory course, students will learn how computers can do useful things with human languages, such as translate from French into English, filter junk email, extract social networks from the web, and find the main topics in the day's news.		
Course Objectives	The objective of this course is to present the main models, formalisms and algorithms necessary for the development of applications in the field of natural language information processing.		
Course Content	• Introduction • Estimation Techniques • Language Modeling • Parsing and Syntax • The EM Algorithm in NLP • Stochastic Tagging • Log-Linear Models • Midterm Exam	• Probabilistic Similarity Measures • Clustering • Machine Translation • Discourse Processing: Segmentation, Anaphora Resolution • Dialogue Systems • Natural Language Generation/Summarization • Unsupervised Methods in NLP	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions	• Group works	

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	20 %	Term Paper	0 %
	Project	20 %	Attendance	0 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Describe the leading trends and systems in natural language processing. 2. Evaluate approaches to discourse, generation, dialogue and summarization within NLP. 3. Recognize the significance of pragmatics for natural language understanding. 4. Describe the simple system based on logic and demonstrate the difference between the semantic presentation and interpretation of that presentation. 5. Describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Jurafsky, David, and James H. Martin. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition. Upper Saddle River, NJ: Prentice-Hall, 2000. ISBN: 0130950696. • Manning, Christopher D., and Hinrich Schütze. Foundations of Statistical Natural Language Processing. Cambridge, MA: MIT Press, 1999. ISBN: 0262133601.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 664	**Course Name:** PHILOSOPHICAL FOUNDATIONS OF ARTIFICIAL INTELLIGENCE		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	In this course students will deal with topics such as: action and agency; behaviorism; belief; computational models of mind; concepts; consciousness; content; context; Davidson and anomalous monism; Dreyfus's criticisms; folk psychology; functionalism; Goedel's theorem; intentionality; the Language of Thought; mental representation; naturalism; perception; possible worlds; practical reasoning; propositional attitudes; rationality; reasons and causes; reference; Searle and Chinese Room; the self; thought and language; Turing Test; Weak AI vs. Strong AI. Previous knowledge of artificial intelligence is required.		
Course Objectives	The objective of this course is to give students understanding of knowledge representation and logic to solve problems of an essentially deterministic nature. Thus, students will learn how to develop intelligent agents that operate in a fairly static, predictable environment.		
Course Content	• Introduction • Concepts of AI (1) • Intelligent agents • Solving problems by searching • Logical agents • First-order logic • Classical planning • Midterm Exam	• Propositional logic • Knowledge representation • Uncertain Knowledge and Reasoning • Planning and Acting in the Real World • Quantifying uncertainties • Probabilistic reasoning • Project presentations	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions	• Group works	

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	20 %	Term Paper	0 %
	Project	20 %	Attendance	0 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Identify problems that are amenable to solution by AI methods, and which AI methods may be suited to solving a given problem. 2. Formalize a given problem in the language/framework of different AI methods (e.g., as a search problem, as a constraint satisfaction problem, as a planning problem, as a Markov decision process, etc.). 3. Implement basic AI algorithms (e.g., standard search algorithms or dynamic programming). 4. Identify and think clearly about the primary concerns and key concepts of the foundations of artificial intelligence. 5. Critically appraise the distinctive arguments which have been developed in this area of philosophy.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach (second edition). • Artificial Intelligence: A Philosophical Introduction, by Jack Copeland. Blackwell. (1993).
Recommended Literature	• Artificial Intelligence: A New Synthesis, by Nils J. Nilsson. Morgan Kaufmann. (1998).

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	0	0	
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 665	**Course Name:** DATA COMMUNICATIONS AND COMPUTER NETWORKS		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course introduces the advanced of data communication and networking. Students will develop an understanding of the general principles of networking as implemented in networks connected to the Internet. Specific attention will be given to the principles of network architecture and layering, multiplexing, network addressing, routing and routing protocols. Activities include setting up a local area network, the Internet, security, network management and network performance analysis.		
Course Objectives	The objective of this course is that the student will develop an understanding of the underlying structure of networks and how they operate.		
Course Content	• Introduction • Data communications concepts; networking criteria; protocols & standards; standards organizations. • Basic Concepts: Line configuration; topology; transmission mode; categories of network; internetworks. • Reference models: The ISO/OSI model; protocol layers; the TCP/IP protocol suite and reference model • Signals: Analog & digital data; periodic and aperiodic signals; simple analog signals; time and frequency domains; frequency spectrum and bandwidth; digital signals. • Transmission Media: Guided media; unguided media; transmission impairment; throughput; propagation speed; propagation time; wavelength; Shannon capacity.	• Multiplexing: FDM; TDM; the telephone system; DSL • Midterm Exam • Error Detection and Correction: Error types; detection process; VCR; LRC CRC; checksum; error correction • Data Link Control: Line discipline; flow control; error control. • Data Link Protocols: Asynchronous protocols; synchronous protocols; character oriented protocols; bit oriented protocols; link access protocol • Local Area Networks: Project 802; Ethernet and its variants. • Networking and Internetworking Devices: Repeaters; routers; bridges; gateways. • TCP/IP Protocol Suite: Internet Protocol; addressing; other network layer protocols (ARP; RARP; ICMP; IGMP). Transport Layer protocols (UDP; TCP). • Project presentations	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions	• Group works	

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Explain basic networking concepts by studying client/server architecture, network scalability, geographical scope, the Internet, intranets and extranets. 2. Identify, describe and give examples of the networking applications used in everyday tasks such as reading email or surfing the web. 3. Describe layered communication, the process of encapsulation, and message routing in network equipped devices using appropriate protocols. 4. Design and build an Ethernet network by designing the subnet structure and configuring the routers to service that network. 5. Manage network management and systems administration. 6. Construct a patch cord to connect a host computer to a network.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Behrouz A. Forouzan. Data Communications and Networking (4th Edition). McGraw Hill. 2007. ISBN: 0-07-296775-7.
Recommended Literature	• William Stallings, Data and Computer Communications, Pearson, 2009 • Dr. K.V. Prasad, Principles of Digital Communication Systems and Computer Networks, Charles River Media, 2003 • Larry L. Peterson & Bruce S. Davie, Computer Networks A Systems Approach, Third Edition, Morgan Kaufmann Publishers, 2003. • Nader F. Mir, Computer and Communication Networks, Prentice Hall, 2006.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	0	0	
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35

Assignment / Homework / Project	1	40	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 667	**Course Name:** IT GOVERNANCE		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	IT governance is about the way in which leadership accomplishes the delivery of mission-critical business capability using Information Technology strategy, goals, and objectives. IT governance is concerned with the strategic alignment between the goals and objectives of the business and the utilization of its IT resources to effectively achieve the desired results. In the course will be presented various methodologies and standards which will help to govern IT using best practices and standards.		
Course Objectives	The main objective of this course is to present IT governance which has task to disseminate authority to the various layers in the organizational structures within specific business, while ensuring appropriate and prudent use of that authority.		
Course Content	• The principles of IT Governance • IT Governance and IT management issues • Responsibility for IT governance • Approaches to IT Governance • COBIT Framework (1) • COBIT Framework (2) • IT Governance Frameworks • Midterm Exam		• Corporate Governance of IT • IT Balanced Scorecard (1) • IT Balanced Scorecard (2) • Frameworks, standards and best practices • Evaluating IT Governance • Applying IT Governance approaches • Project presentations
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	40 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	60 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Identify and prioritize information assets 2. Identify and prioritize threats to information assets 3. Define an information security strategy and architecture 4. Plan for and respond to intruders in an information system 5. Describe legal and public relations implications of security and privacy issues 6. Present a disaster recovery plan for recovery of information assets after an incident.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• International IT Governance: Alan Calder & Steve Watkins, Koganb Page, 206
Recommended Literature	• Business Continuity Planning Methodology, Akhtar Syed, Afsar Syed, Sentryx 2004. • The Disaster Recovery Handbook, Michael Wallace and Lawrence Webber, Amacom, 2004. • Disaster Recovery Planning, John William ToigoPrentice Hall, 2003. • Application Security in the ISO 27001 Environment, Vinnod Avasudavan et al. IT Governance Publishing 2008. • Text of standards: ISO 27001, 27002, 27003, 2700, 20000-1, 20000-2, ISO / IEC • Business Continuity BS 25999-1 and BS 25999-2, British Standardisation Institute.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)			
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination			
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	1	60	60
Seminar / Presentation			
Total Workload			142
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 669	**Course Name:** SPECIAL TOPICS IN MACHINE LEARNING		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course covers machine learning techniques and statistical pattern recognition, supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks, support vector machines); unsupervised learning (clustering, dimensionality reduction, kernel methods); learning theory (bias/variance trade-offs; large margins); reinforcement learning and adaptive control, applications areas (data mining, bioinformatics, speech recognition, and text and web data processing).		
Course Objectives	Objective of the course is to present the key algorithms and theory that form the core of machine learning; draw on concepts and results from many fields, including statistics, artificial intelligence, philosophy, information theory, biology, cognitive science, computational complexity, and control theory.		
Course Content	• Concept Learning • Bayesian Learning, • Computational Learning Theory • Machine learning techniques and statistical pattern recognition • Supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks) • Supervised learning (support vector machines) • Unsupervised learning (clustering, dimensionality reduction, kernel methods) (1) • Midterm Exam	• Unsupervised learning (clustering, dimensionality reduction, kernel methods) (2) • Learning theory (bias/variance trade-offs; VC theory; large margins) • Reinforcement learning and adaptive control • Applications areas (robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing). • Evaluation Hypotheses • Decision Tree Learning (1) • Decision Tree Learning (2)	
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	25 %	Attendance	0 %
	Midterm Exam	25 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	50 %
	Total	**100 %**		

Learning Outcomes	After completion of the course, students will be able to: 1. Describe basic machine learning and Bayesian reasoning methods. 2. Identify and understand real-world applications of machine learning methods. 3. Experience on analyzing real-world data with the integration of relationships among different variables. 4. Develop an appreciation for what is involved in learning models from data. 5. Apply the algorithms to a real problem, optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• T. Hastie,R. Tibshirani, J. Friedman, *The Elements of Statistical Learning*, Second Edition, Springer, 2008.
Recommended Literature	• Mitchell T., *Machine Learning*, McGraw Hill, 1997. • Du and Swamy, *Neural Networks in a Softcomputing Framework*, Springer-Verlag London Limited, 2006. • Sebe, Cohen, Garg and Huang, *Machine Learning in Computer Vision*, Springer, 2005.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	1	40	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 670	**Course Name:** SPECIAL TOPICS IN DATA MINING		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course covers: overview of Data Mining Classification, regression, time series. Measuring predictive performance. Data preparation, data reduction. Mathematical solutions, statistical methods, distance solutions, decision trees, decision rules.		
Course Objectives	Objective of this course is to introduce to students advanced concepts and techniques of Data Mining, data mining software for solving practical problems and ability to do independent study and research.		
Course Content	• Introduction to Data Mining Principles • Data Warehousing, Data Mining, and OLAP • Data Preprocessing and Dimension Reduction in Data Mining • Regression Modelling • Naïve Bayes Estimation and Bayesian Networks • Classification • Prediction • Midterm Exam		• Cluster Analysis • Mining Stream, Time-Series, and Sequence Data • Mining Object, Spatial, Multimedia, Text, and Web Data • Emerging Trends and Applications of Data Mining • Data Mining Trends and Knowledge Discovery • Data Mining Tasks, Techniques, and Applications • Project presentations
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	25 %	Attendance	0 %
	Midterm Exam	25 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	50 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Differentiate variety of data mining techniques including: association rule mining, classification, clustering and graph mining in terms of algorithms and modelling. 2. Learn the interdisciplinary nature and forefront research topics in data mining. 3. Determine whether an application can be solved by data mining techniques, if so, which techniques should be applied to. 4. Develop a novel algorithm to solve a general data mining problem or apply one or more data mining techniques to a particular dataset, through course project. 5. Implement standard data-mining algorithms.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining, Practical Machine Learning Tools and Techniques, Morgan Kaufmann Publishers, Elsevier Inc., Third Edition, 2011.
Recommended Literature	• S. Sumathi, S.N. Sivanandam, Introduction to Data Mining and its Applications, Springer-Verlag Berlin Heidelberg 2006. • Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, Morgan Kaufmann, Elsevier Inc., Second Ed., 2006. • D. T. Larose, Data Mining Methods and Models, John Wiley & Sons, Inc., 2006. • T. M. Mitchell, Machine Learning, McGraw Hill, 1997. • T. Hastie, R. Tibshirani, and J. Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer-Verlag, Second Ed., 2008.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	1	40	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 671	**Course Name:** SPECIAL TOPICS IN PATTERN RECOGNITION		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45

Course Description	This class deals with the fundamentals of characterizing and recognizing patterns and features of interest in digital data. We discuss the basic tools and theory for understanding problems with applications to pattern recognition. We also cover decision theory, statistical classification, maximum likelihood and Bayesian estimation, nonparametric methods, unsupervised learning and clustering. Additional topics on new pattern recognition algorithms and techniques from active research are also talked about in the class.
Course Objectives	Objective of this course is to give to students sufficient background necessary to read more advance texts as well as journal articles on the field. Several applications of pattern recognition on classical computer and electrical engineering problems (e.g. word/sentence-based searches, signal analysis, speech and visual processing, engineering system design, medical diagnosis, etc.) will show the student how to use pattern recognition in real settings. The student will also be introduced to more recent applications of pattern recognition, such as cognitive neuroscience and bioinformatics. Students will work on a selected project.
Course Content	• Introduction to statistical pattern recognition • Maximum likelihood and Bayesian parameter estimation • Classifiers Based on Bayes Decision Theory • Linear regression • Linear and Nonlinear Classifiers • Multilayer Neural Networks • Nonparametric techniques (k-NN) • Midterm Exam • Decision Tree Based Methods • Feature Extraction and Selection • Data Transformation and Dimensionality Reduction • Template Matching • Context Dependent Classification (HMM) • System Performance Evaluation • Unsupervised Learning and Clustering
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	25 %	Attendance	0 %
	Midterm Exam	25 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	50 %
	Total	**100 %**		

Learning Outcomes	After completion of the course, students will be able to: 1. Design systems and algorithms for pattern recognition (signal classification), with focus on sequences of patterns that are analyzed using, e.g., hidden Markov models (HMM), 2. Analyze classification problems probabilistically and estimate classifier performance. 3. Understand and analyse methods for automatic training of classification systems. 4. Apply Maximum-likelihood parameter estimation in relatively complex probabilistic models, such as mixture density models and hidden Markov models. 5. Understand the principles of Bayesian parameter estimation and apply them in relatively simple probabilistic models.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• S. Theodoridis, K. Koutroumbas, *Pattern Recognition & MATLAB Intro*, Elsevier, 2010.
Recommended Literature	• R. O. Duda, P. E. Hart and D. Stork, *Pattern Classification*, 2nd. Edition, John Wiley & Sons, 2002. • K C. Bishop, *Pattern Recognition and Machine Learning*, Springer 2006. • L. I. Kuncheva, *Combining Pattern Classifiers, Methods and Algorithms*, John Wiley & Sons, Inc., 2004. • S. Theodoridis, A. Pikrakis, K. Koutroumbas, D. Cavouras, *Introduction to Pattern Recognition A MATLAB Approach*, Academic Press, Elsevier Inc. 2010. • Menahem Friedman, Abraham Kandel, *Introduction to Pattern Recognition, Statistical, Structural, Neural and Fuzzy Logic Approaches*, World Scientific Publishing Company, 1999. • S. K. Pal, A. Pal, *Pattern Recognition, From Classical to Modern Approaches*, World Scientific Publishing Company, 2001. • A. R. Webb , *Statistical Pattern Recognition*, Second Edition, John Wiley & Sons, Ltd., 2002.

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	1	40	40
Seminar / Presentation			

Total Workload	149
ECTS Credit (Total Workload / 25)	6

Course Code: CEN 673	**Course Name:** SPECIAL TOPICS IN BIOINFORMATICS		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	The course is designed to introduce the advanced concepts, methods, and tools used in Bioinformatics. Topics include (but not limited to) bioinformatics databases, sequence and structure alignment, protein structure prediction, protein folding, protein-protein interaction, Monte Carlo simulation, and molecular dynamics. Emphasis will be put on the understanding and utilization of these concepts and algorithms.		
Course Objectives	Objectives of this course are to introduce future biologists and physicians to bioinformatics tools and analysis methods and to help the students to reach rapidly the frontier of bioinformatics and be able to use the bioinformatics tools to solve the problems on their own research.		
Course Content	• Molecular evolution and gene finding • Sequence comparison methods • Amino acid residue conservation • Function prediction from protein sequence • Protein structure comparison, classifications and prediction • Comparative modeling • From protein structure to function • Midterm Exam		• From structure-based genome annotation to understanding genes and proteins • Global approaches for studying protein-protein interactions. • Predicting the structure of protein-biomolecular interactions. • Experimental use of DNA arrays. • Mining gene expression data and proteomics • Data management of biological information. • Internet technologies for bioinformatics.
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	10 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Work with the vast amounts of biomedical and genomic data and online tools that will be relevant to their work in the coming decades. 2. Explain the fundamental concepts of a special topic in bioinformatics and its role in modern mathematics and applied contexts. 3. Demonstrate accurate and efficient use of specific bioinformatics techniques. 4. Demonstrate capacity for mathematical reasoning through analysing, proving and explaining concepts from bioinformatics. 5. Differentiate internet technologies for bioinformatics.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• C. Orengo, D. Jones, J. Thornton, Bioinformatics: genes, proteins and computers, BIOS Scientific Publishers Limited, 2003.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 682	**Course Name:** SPECIAL TOPICS IN COMPUTERS AND NETWORK SECURITY		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45

Course Description	As our society depends more on computers and the Internet, computer and network security has become one of the primary concerns and requirements for most people and organizations. In this seminar-type course, we will introduce state-of-the-art research papers on various computer and network related security issues.
Course Objectives	Through this course, students will obtain the general knowledge and comprehensive understandings of security related issues in computers and networks; understand the frontiers in security research, so that they can quickly conduct their own security-related research on topics they are interested. This special topics course is highly interactive. Besides brief introductory lectures from the instructor, students will participate by presenting papers during class, discussing pros and cons of each paper, discussing how to conduct further research based on presented papers, reviewing selected papers as homework assignments, and having a final research-type group project (term paper).
Course Content	• Internet malware (virus, worm, spam, etc.) modeling • Internet malware analysis and defense • Intrusion detection • Intrusion prevention • Denial-of-Service (DoS) attack defense • Wireless network security • Sensor network security • Midterm Exam • Software and security • Secure hardware architecture. • Various attacks • Emerging applications security • Privacy issues such as RFID • Project presentations • Preparation for final exam
Teaching Methods Description	• Interactive lectures and communications with students • Discussions and group works

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	10 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Apply cryptography in the development of advanced secure networked systems. 2. Analyze and design elementary cryptographic authentication protocols. 3. Compromise network systems by exploiting common vulnerabilities. 4. Use cryptographic APIs to provide confidentiality, integrity and authentication across networked application systems. 5. Distinguish between different types of security policy model. 6. Compromise existing systems by exploiting common vulnerabilities. 7. Develop applications that avoid basic security vulnerabilities.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Computer Security: Principles and Practice (2nd Edition), Pearson Press
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 691	**Course Name:** FUZZY SYSTEMS AND CONTROL		
Level: PhD	**Year:**I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	Fuzzy logic is a tool that can be applied to ambiguous, complicated, complex, or nonlinear systems or problems, which cannot easily solved by classical techniques. This course discusses the fundamental of fuzzy set theory and fuzzy logic. In addition, this course also introduces applications of fuzzy logic in several areas.		
Course Objectives	Objective of this course is to: develop the ability to design and analyze systems involving fuzzy logic.		
Course Content	• Intro. to Fuzzy Logic • Fuzzy Sets and Operations • Fuzzy Relations • Fuzzy Logic (1) • Fuzzy Logic (2) • Membership Functions, Fuzzification, Defuzzification (1) • Membership Functions, Fuzzification, Defuzzification (2) • Membership Functions, Fuzzification, Defuzzification (3) • Fuzzy Rule-base System • Fuzzy Inference • Applications with MATLAB (1) • Applications with MATLAB (2) • Presentations (1) • Presentations (2) • Presentations (3)		
Teaching Methods Description	• Interactive lectures and communication with students • Practical Sessions		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	40 %
	Homework	0 %	Term Paper	0 %
	Assignment	0 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	30 %	Final Exam	30 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Describe and compute vague concepts using fuzzy sets and fuzzy logic. 2. Design fuzzy rules and perform fuzzy reasoning on them. 3. Illustrate the organization, design and operation of some common fuzzy systems. 4. Know how to use fuzzy systems to solve real-world problems. 5. Define the basic mathematical concepts of fuzzy sets
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• T. J. Ross, Fuzzy logic with engineering applications, 1 ed. New York, NY: McGraw-Hill • H.-J. Zimmermann, Fuzzy set theory and its applications, 3 ed. Norwell, MA: Kluwer
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory/Practice hours per week)			
Midterm Examination (1 week)			
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination			
Preparation for Final Examination	1	35	35
Assignment / Homework/ Project	1	40	40
Seminar	1	32	32
Total Workload			154
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 692	**Course Name:** SEMINAR I		
Level: PhD	**Year:** I	**Semester:** I	**ECTS Credits:** 6
Status: Compulsory	**Hours/Week:** 3		**Total Hours:** 45
Course Description	Seminar I is intended to assist doctoral students in the preparation of a dissertation proposal and to facilitate the transition from course work to dissertation. This course will review of proposal components, with particular emphasis on research design and developing the literature review, and will also focus on key issues such as dissertation format standards, psychological and time management demands, committee formation, and project management.		
Course Objectives	Objective of this course is to attempt to apply students' cumulative understanding and skills to specific research situation. From the perspective of one's program of study, however, this course poses a real-world test helping to make a realistic transition from coursework to dissertation.		
Course Content	• Thesis: What to Expect? (1) • Thesis: What to Expect? (2) • Problems and Questions (1) • Problems and Questions (2) • Literature Review (1) • Literature Review (2) • Literature Review (3) • Presentations • Research Design (1) • Research Design (2) • Research Design (3) • Analysis, Writing, and Ethical Considerations (1) • Analysis, Writing, and Ethical Considerations (2) • Analysis, Writing, and Ethical Considerations (3) • Presentation and Wrap up		
Teaching Methods Description	• Interactive lectures • Tutorial		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	0 %	Attendance	10 %
	Midterm Exam	0 %	Class Deliverables	50 %
	Presentation	40 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Apply your theoretical and methodological understanding and skills into devising researchable ideas and specific research questions and hypotheses. 2. Conduct a focused review of the relevant literature and create appropriate conceptual framework. 3. Develop a realistic research design with specific research strategies. 4. Think through and articulate a chapter-by-chapter outline of the intended dissertation. 5. Communicate research ideas and their appropriate theoretical and methodological issues effectively and efficiently. 6. Critique other's ideas paying particular attention to both theoretical and methodological rigor and reality. 7. Gain understanding of the process of dissertation including stress, time, and project management, committee formation, dissertation proposition and defense, and human subjects reviews.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Rudestam, K.E. & Newton, R.R. 2007. Surviving Your Dissertation: A Comprehensive Guide to Content and Process (3rd ed.). Thousand Oaks: Sage Publications. [ISBN: 9781412916790]
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	15		
Midterm Examination (1 week)			
Final Examination (1 week)			
Preparation for Midterm Examination			
Preparation for Final Examination			
Assignment / Homework / Project	5	10	50
Seminar / Presentation	5	10	50
Total Workload			145
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 693	**Course Name:** SEMINAR II		
Level: PhD	**Year:** I	**Semester:** II	**ECTS Credits:** 6
Status: Compulsory	**Hours/Week:** 3		**Total Hours:** 45
Course Description	Seminar II is continuation of Seminar I. It is intended to assist doctoral students in the preparation of a dissertation proposal and to facilitate the transition from course work to dissertation. This course will review of proposal components, with particular emphasis on research design and developing the literature review, and will also focus on key issues such as dissertation format standards, psychological and time management demands, committee formation, and project management.		
Course Objectives	Objective of this course is to attempt to apply students' cumulative understanding and skills to specific research situation. From the perspective of one's program of study, however, this course poses a real-world test helping to make a realistic transition from coursework to dissertation.		
Course Content	• Thesis: What to Expect? (1) • Thesis: What to Expect? (2) • Problems and Questions (1) • Problems and Questions (2) • Literature Review (1) • Literature Review (2) • Literature Review (3) • Presentations • Research Design (1) • Research Design (2) • Research Design (3) • Analysis, Writing, and Ethical Considerations (1) • Analysis, Writing, and Ethical Considerations (2) • Analysis, Writing, and Ethical Considerations (3) • Presentation and Wrap up		
Teaching Methods Description	• Interactive lectures • Tutorial		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	0 %	Attendance	10 %
	Midterm Exam	0 %	Class Deliverables	50 %
	Presentation	40 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 3. Apply your theoretical and methodological understanding and skills into devising researchable ideas and specific research questions and hypotheses. 4. Conduct a focused review of the relevant literature and create appropriate conceptual framework. 5. Develop a realistic research design with specific research strategies. 6. Think through and articulate a chapter-by-chapter outline of the intended dissertation. 7. Communicate research ideas and their appropriate theoretical and methodological issues effectively and efficiently. 8. Critique other's ideas paying particular attention to both theoretical and methodological rigor and reality. 9. Gain understanding of the process of dissertation including stress, time, and project management, committee formation, dissertation proposition and defense, and human subjects reviews.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Rudestam, K.E. & Newton, R.R. 2007. Surviving Your Dissertation: A Comprehensive Guide to Content and Process (3rd ed.). Thousand Oaks: Sage Publications. [ISBN: 9781412916790]
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	15		
Midterm Examination (1 week)			
Final Examination (1 week)			
Preparation for Midterm Examination			
Preparation for Final Examination			
Assignment / Homework / Project	5	10	50
Seminar / Presentation	5	10	50
Total Workload			145
ECTS Credit (Total Workload / 25)			6

Course Code: CEN 695	**Course Name:** PHD DISSERTATION I		
Level: PhD	**Year:** II	**Semester:** III	**ECTS Credits:** 30
Status: Compulsory	**Hours/Week:** 0		**Total Hours:** 0
Course Description	PhD dissertation is done through four semesters/two academic years. During that time, each graduate student is expected to independently work on a chosen research project and apply practically most of the IT methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study and to publish scientific papers in recognized scientific journals. At the end of their doctoral studies, each student should submit a PhD dissertation and defend it in the form of oral presentation in front of a committee consisted of five juries.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: Providing and outline of how to perform a literature review; Explaining the scientific approach to research questions; Teaching how to carry out a scientific study and appropriately manage its data; Giving an overview of ethics involved in animal and/or human research; Explaining how to express oneself clearly in science (when speaking and writing).		
Course Content	• Chapter 1: The Research Process • Chapter 2: Selecting a Suitable Topic • Chapter 3: Methods of Inquiry: Quantitative and Qualitative Approaches • Chapter 4: Literature Review and Statement of the Problem • Chapter 5: The Method Chapter: Describing Your Research Plan • Chapter 6: Presenting the Results of Quantitative Studies	• Chapter 7: Presenting the Results of Qualitative Research • Chapter 8: Discussion • Chapter 9: Overcoming Barriers: Becoming an Expert While Controlling Your Own Destiny • Chapter 10: Writing • Chapter 11: How to Complete Your Dissertation Using Online Data Access and Collection • Chapter 12: Guidelines for the Presentation of Numbers in the Dissertation • Chapter 13: Informed Consent and Other Ethical Concerns	
Teaching Methods Description	• Interactive lectures • Tutorial		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	50 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	50 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Apply your theoretical and methodological understanding and skills into devising researchable ideas and specific research questions and hypotheses. 2. Conduct a focused review of the relevant literature and create appropriate conceptual framework. 3. Develop a realistic research design with specific research strategies. 4. Think through and articulate a chapter-by-chapter outline of the intended dissertation. 5. Communicate research ideas and their appropriate theoretical and methodological issues effectively and efficiently. 6. Critique other's ideas paying particular attention to both theoretical and methodological rigor and reality. 7. Gain understanding of the process of dissertation including stress, time, and project management, committee formation, dissertation proposition and defense, and human subjects reviews.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Rudestam, K.E. & Newton, R.R. 2007. Surviving Your Dissertation: A Comprehensive Guide to Content and Process (3rd ed.). Thousand Oaks: Sage Publications. [ISBN: 9781412916790]
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Literature review and consultation	1	200	200
Research / Laboratory / field work	1	250	250
Thesis writing process	1	100	100
Data analysis and reporting	0	150	150
Seminar / Presentation (including defense)	4	12	48
Total Workload			748
ECTS Credit (Total Workload / 25)			30

Course Code: CEN 696	**Course Name:** PHD DISSERTATION II		
Level: PhD	**Year:** II	**Semester:** IV	**ECTS Credits:** 30
Status: Compulsory	**Hours/Week:** 0		**Total Hours:** 0
Course Description	PhD dissertation is done through four semesters/two academic years. During that time, each graduate student is expected to independently work on a chosen research project and apply practically most of the IT methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study and to publish scientific papers in recognized scientific journals. At the end of their doctoral studies, each student should submit a PhD dissertation and defend it in the form of oral presentation in front of a committee consisted of five juries.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: Providing and outline of how to perform a literature review; Explaining the scientific approach to research questions; Teaching how to carry out a scientific study and appropriately manage its data; Giving an overview of ethics involved in animal and/or human research; Explaining how to express oneself clearly in science (when speaking and writing).		
Course Content	• Chapter 1: The Research Process • Chapter 2: Selecting a Suitable Topic • Chapter 3: Methods of Inquiry: Quantitative and Qualitative Approaches • Chapter 4: Literature Review and Statement of the Problem • Chapter 5: The Method Chapter: Describing Your Research Plan • Chapter 6: Presenting the Results of Quantitative Studies	• Chapter 7: Presenting the Results of Qualitative Research • Chapter 8: Discussion • Chapter 9: Overcoming Barriers: Becoming an Expert While Controlling Your Own Destiny • Chapter 10: Writing • Chapter 11: How to Complete Your Dissertation Using Online Data Access and Collection • Chapter 12: Guidelines for the Presentation of Numbers in the Dissertation • Chapter 13: Informed Consent and Other Ethical Concerns	
Teaching Methods Description	• Interactive lectures • Tutorial		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	50 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	50 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Apply your theoretical and methodological understanding and skills into devising researchable ideas and specific research questions and hypotheses. 2. Conduct a focused review of the relevant literature and create appropriate conceptual framework. 3. Develop a realistic research design with specific research strategies. 4. Think through and articulate a chapter-by-chapter outline of the intended dissertation. 5. Communicate research ideas and their appropriate theoretical and methodological issues effectively and efficiently. 6. Critique other's ideas paying particular attention to both theoretical and methodological rigor and reality. 7. Gain understanding of the process of dissertation including stress, time, and project management, committee formation, dissertation proposition and defense, and human subjects reviews.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Rudestam, K.E. & Newton, R.R. 2007. Surviving Your Dissertation: A Comprehensive Guide to Content and Process (3rd ed.). Thousand Oaks: Sage Publications. [ISBN: 9781412916790]
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Literature review and consultation	1	200	200
Research / Laboratory / field work	1	250	250
Thesis writing process	1	100	100
Data analysis and reporting	0	150	150
Seminar / Presentation (including defense)	4	12	48
Total Workload			748
ECTS Credit (Total Workload / 25)			30

Course Code: CEN 697	**Course Name:** PHD DISSERTATION III		
Level: PhD	**Year:** III	**Semester:** V	**ECTS Credits:** 30
Status: Compulsory	**Hours/Week:** 0		**Total Hours:** 0
Course Description	PhD dissertation is done through four semesters/two academic years. During that time, each graduate student is expected to independently work on a chosen research project and apply practically most of the IT methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study and to publish scientific papers in recognized scientific journals. At the end of their doctoral studies, each student should submit a PhD dissertation and defend it in the form of oral presentation in front of a committee consisted of five juries.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: Providing and outline of how to perform a literature review; Explaining the scientific approach to research questions; Teaching how to carry out a scientific study and appropriately manage its data; Giving an overview of ethics involved in animal and/or human research; Explaining how to express oneself clearly in science (when speaking and writing).		
Course Content	• Chapter 1: The Research Process • Chapter 2: Selecting a Suitable Topic • Chapter 3: Methods of Inquiry: Quantitative and Qualitative Approaches • Chapter 4: Literature Review and Statement of the Problem • Chapter 5: The Method Chapter: Describing Your Research Plan • Chapter 6: Presenting the Results of Quantitative Studies	• Chapter 7: Presenting the Results of Qualitative Research • Chapter 8: Discussion • Chapter 9: Overcoming Barriers: Becoming an Expert While Controlling Your Own Destiny • Chapter 10: Writing • Chapter 11: How to Complete Your Dissertation Using Online Data Access and Collection • Chapter 12: Guidelines for the Presentation of Numbers in the Dissertation • Chapter 13: Informed Consent and Other Ethical Concerns	
Teaching Methods Description	• Interactive lectures • Tutorial		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	50 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	50 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Apply your theoretical and methodological understanding and skills into devising researchable ideas and specific research questions and hypotheses. 2. Conduct a focused review of the relevant literature and create appropriate conceptual framework. 3. Develop a realistic research design with specific research strategies. 4. Think through and articulate a chapter-by-chapter outline of the intended dissertation. 5. Communicate research ideas and their appropriate theoretical and methodological issues effectively and efficiently. 6. Critique other's ideas paying particular attention to both theoretical and methodological rigor and reality. 7. Gain understanding of the process of dissertation including stress, time, and project management, committee formation, dissertation proposition and defense, and human subjects reviews.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Rudestam, K.E. & Newton, R.R. 2007. Surviving Your Dissertation: A Comprehensive Guide to Content and Process (3rd ed.). Thousand Oaks: Sage Publications. [ISBN: 9781412916790]
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Literature review and consultation	1	200	200
Research / Laboratory / field work	1	250	250
Thesis writing process	1	100	100
Data analysis and reporting	0	150	150
Seminar / Presentation (including defense)	4	12	48
Total Workload			748
ECTS Credit (Total Workload / 25)			30

Course Code: CEN 698	**Course Name:** PHD DISSERTATION IV		
Level: PhD	**Year:** III	**Semester:** VI	**ECTS Credits:** 30
Status: Compulsory	**Hours/Week:** 0		**Total Hours:** 0
Course Description	PhD dissertation is done through four semesters/two academic years. During that time, each graduate student is expected to independently work on a chosen research project and apply practically most of the IT methods in their research work. Students are expected to widen their theoretical and practical knowledge in the area of study and to publish scientific papers in recognized scientific journals. At the end of their doctoral studies, each student should submit a PhD dissertation and defend it in the form of oral presentation in front of a committee consisted of five juries.		
Course Objectives	The cognitive, affective and behavioral objectives of this course are following: Providing and outline of how to perform a literature review; Explaining the scientific approach to research questions; Teaching how to carry out a scientific study and appropriately manage its data; Giving an overview of ethics involved in animal and/or human research; Explaining how to express oneself clearly in science (when speaking and writing).		
Course Content	• Chapter 1: The Research Process • Chapter 2: Selecting a Suitable Topic • Chapter 3: Methods of Inquiry: Quantitative and Qualitative Approaches • Chapter 4: Literature Review and Statement of the Problem • Chapter 5: The Method Chapter: Describing Your Research Plan • Chapter 6: Presenting the Results of Quantitative Studies	• Chapter 7: Presenting the Results of Qualitative Research • Chapter 8: Discussion • Chapter 9: Overcoming Barriers: Becoming an Expert While Controlling Your Own Destiny • Chapter 10: Writing • Chapter 11: How to Complete Your Dissertation Using Online Data Access and Collection • Chapter 12: Guidelines for the Presentation of Numbers in the Dissertation • Chapter 13: Informed Consent and Other Ethical Concerns	
Teaching Methods Description	• Interactive lectures • Tutorial		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	50 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	50 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Apply your theoretical and methodological understanding and skills into devising researchable ideas and specific research questions and hypotheses. 2. Conduct a focused review of the relevant literature and create appropriate conceptual framework. 3. Develop a realistic research design with specific research strategies. 4. Think through and articulate a chapter-by-chapter outline of the intended dissertation. 5. Communicate research ideas and their appropriate theoretical and methodological issues effectively and efficiently. 6. Critique other's ideas paying particular attention to both theoretical and methodological rigor and reality. 7. Gain understanding of the process of dissertation including stress, time, and project management, committee formation, dissertation proposition and defense, and human subjects reviews.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Rudestam, K.E. & Newton, R.R. 2007. Surviving Your Dissertation: A Comprehensive Guide to Content and Process (3rd ed.). Thousand Oaks: Sage Publications. [ISBN: 9781412916790]
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Literature review and consultation	1	200	200
Research / Laboratory / field work	1	250	250
Thesis writing process	1	100	100
Data analysis and reporting	0	150	150
Seminar / Presentation (including defense)	4	12	48
Total Workload			748
ECTS Credit (Total Workload / 25)			30

Course Code: EEE 631	**Course Name:** STOCHASTIC SIGNALS AND SYSTEMS I		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course covers: meaning and axioms of probability, conditional probability. Combined experiments, Bernoulli trials, asymptotic theorems, Poisson theorem and random points. Random variables: Distribution and density functions, conditional distributions and total probability. Functions of random variables: mean and variance, moments, characteristic functions, bivariate distributions, mean square estimation. Sequences of random variables. Stochastic convergence and limit theorems, random numbers. Parameter estimation and hypothesis testing.		
Course Objectives	The objective of this course is to provide the students with a solid understanding on: he meaning and axioms of probability, repeated trials and the concept of a random variable, continuous and discrete functions of random variables, moments and conditional distributions, and sequences of random variables.		
Course Content	• Definitions, probability and induction, causality versus randomness, • Set theory, probability space, conditional probability • Combined experiments, Bernoulli trials, asymptotic theorems, • Poisson theorem and random points • Distribution and density functions, special cases; Conditional distributions and total probability • The random variable and its distribution • Mean and variance • Midterm Exam	• Moments, characteristic functions • Bivariate distributions, one function of random variables; Two functions of random variables • Joint moments and characteristic functions • Conditional distributions and expected values • Mean square estimation • Conditional densities, characteristic functions and normality • Mean square estimation, stochastic convergence and limit theorems, random numbers	
Teaching Methods Description	• Interactive lectures • Tutorial		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	10 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Apply the concept of probability to experiments that have random outcomes. 2. Recognize a random variable and its properties. 3. Recognize a bivariate random vector and its properties. 4. Apply the concept of statistical estimation. 5. Identify random phenomena incorporating the element of time that are embedded in real-life physical processes in electrical engineering systems.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Athanasios Papoulis and S. Unnikrishna Pillai, "Probability, Random Variables, and Stochastic Processes, 4th Ed., McGraw-Hill, 2002.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: EEE 632	**Course Name:** STOCHASTIC SIGNALS AND SYSTEMS II		
Level: PhD	**Year:** I	**Semester:**	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course covers: Systems with stochastic inputs, the power spectrum, digital processes. Basic applications: Random walk, Brownian motion, thermal noise, modulation, cyclostationary processes, bandlimited processes and sampling theory, bispectra and system identification. Factorization and innovations, finite-order systems and state variables, Fourier series and Karhunen-Loéve expansions, spectral representation of random processes. Ergodicity, spectral estimation, extrapolation and system identification. Mean Square Estimation. Kalman filters. Entropy methods. Shot noise and Markoff Processes.		
Course Objectives	The objective of this course is to provide the students with a solid understanding on: Stochastic processes and their applications, factorization and innovations, spectral representation of random processes, spectral estimation and ergodicity, mean square estimation, and Markoff processes.		
Course Content	• Introduction to stochastic processes • Systems with stochastic inputs • The power spectrum and digital processes • Random walk, Brownian motion, thermal noise, Poisson points and shot noise • Modulation and cyclostationary processes • Bandlimited processes and sampling theory • Bispectra and system identification • Midterm Exam		• Factorization and innovations, finite-order systems and state variables • Fourier series and Karhunen-Loéve expansions, spectral representation of random processes • Ergodicity and spectral estimation • Ergodicity, spectral estimation and Mean Square Estimation • Kalman filters • The maximum entropy method, coding and channel capacity • Shot noise and Markoff Processes
Teaching Methods Description	• Interactive lectures • Tutorial		

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	0 %
	Project	20 %	Attendance	10 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	0 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Show a basic understanding of properties of stochastic processes. 2. Analyze given problems in estimation or optimal filtering. 3. Apply mathematical modeling tools to problems in electrical engineering. 4. Show an understanding about sampling and reconstruction of weakly stationary stochastic processes. 5. Use a given mathematical model, or formulate one on your own, to solve a given technical problem in the area, analyze the result and justify if it is reasonable.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Athanasios Papoulis and S. Unnikrishna Pillai, "Probability, Random Variables, and Stochastic Processes, 4th Ed., McGraw-Hill, 2002.
Recommended Literature	

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)			
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	2	2
Preparation for Midterm Examination	1	25	25
Preparation for Final Examination	1	35	35
Assignment / Homework / Project	2	20	40
Seminar / Presentation			
Total Workload			149
ECTS Credit (Total Workload / 25)			6

Course Code: MAN 608	**Course Name:** ADVANCED STATISTICS		
Level: PhD	**Year:** I	**Semester:** II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This applied course is designed for graduate students with a prior background in statistics. This means that students should have considerable experience with multiple regressions and an ability to conduct such analyses using some statistical software. The major topics of the course will include hierarchical linear modeling and structural equation modeling.		
Course Objectives	This course aims to refresh the statistical knowledge of the students and present advanced statistical methods which will possibly be needed during dissertation and further academic studies.		
Course Content	• Introduction • Descriptive Statistics • Measures and Central Tendency • Measures of Dispersion • The Normal Curve • Sampling and Sampling Distribution • Estimation Procedures • Midterm Exam	• One Sample Test • Two Sample Test • ANOVA • Chi Square • Bivariate Measures and Associations • Multivariate Techniques • Preparation for Final Exam	
Teaching Methods Description	• Practical Sessions • Presentation	• Assignments • Case Studies	

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	0 %
	Project	0 %	Attendance	0 %
	Midterm Exam	30 %	Class Deliverables	0 %
	Presentation	20 %	Final Exam	50 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Demonstrate the ability to apply fundamental concepts in exploratory data analysis. 2. Demonstrate an appreciation of one—way analysis of variance (ANOVA). 3. Demonstrate an understanding of the basic concepts of probability and random variables. 4. Demonstrate understanding of the concept of the sampling distribution of a statistic, and in particular describe the behaviour of the sample mean. 5. Apply inferential methods relating to the means of Normal distributions. 6. Interpret and analyze data that may be displayed in a two—way table.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Joseph F. Healey, Statistics: a tool for social research, 8th edition, Wadsworth Cengage Learning, 2008, 2005, ISBN:0-534-62810-9
Recommended Literature	• Gerard Keller, Statistics for management and economics, 2005, ISBN:9780495013396

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	0	0	0
Midterm Examination (1 week)	0	0	0
Final Examination (1 week)	1	3	3
Preparation for Midterm Examination	0	0	0
Preparation for Final Examination	1	30	30
Assignment / Homework / Project	2	20	40
Seminar / Presentation	2	15	30
Total Workload			148
ECTS Credit (Total Workload / 25)			6

Course Code: MAN 617	**Course Name:** FORECASTING TECHNIQUES		
Level: PhD	**Year:** I	**Semester:** II	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	The simplest definition of economic forecasting is that it is a process that has as its objective the prediction of future events or conditions to reduce that uncertainty so that our decisions will be better ones. Emphasis is on a combination of the mathematical development of forecasting models and their application to data. The applications are in lab sessions in which students will be instructed in using an econometrics computer package and asked to solve problems using that package.		
Course Objectives	The general objectives for this course are to: provide students with an understanding of data analysis applicable to developing economic forecasts; provide an understanding of forecasting error metrics; provide students with the basics of economic forecasting methods and models; expose them to the use of a computer package for developing forecasting models; allow to apply the techniques learned in the course to lab assignments; make policy recommendations (private and public) based on rational forecasts.		
Course Content	• Introduction to forecasting • Review of Basic Statistical Concepts • Data Patterns and Forecasting Techniques (1) • Data Patterns and Forecasting Techniques (2) • Moving Averages and Smoothing Methods (1) • Moving Averages and Smoothing Methods (2) • Project discussion	• Time Series and their Components (1) • Time Series and their Components (2) • Box-Jenkins Type Forecasting Models (1) • Box-Jenkins Type Forecasting Models (2) • Simple Linear Regression (1) • Simple Linear Regression (2) • Multiple Regression Analysis/Time Series (1) • Multiple Regression Analysis/Time Series (2)	
Teaching Methods Description	• Interactive lectures and communication with students • Discussions and group work	• Problem solving or case studies • Lab work	

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	40 %
	Homework	10 %	Term Paper	0 %
	Project	30 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	20 %
	Presentation	0 %	Final Exam	0 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Use statistical software packages to analyse data and apply forecasting techniques. 2. Apply the methods to practical problems. 3. Show practical experience by being exposed to problems based on real data. 4. Use computing packages such as EXCEL, MINITAB and similar. 5. Evaluate forecast error measures. 6. Identify and discuss features of appropriate forecasting models. 7. Manipulate the mathematical and statistical properties of classes of forecasting models.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Introduction to Time Series and Forecasting Montgomery et al. Publisher: J. Wiley & Sons
Recommended Literature	• Business Forecasting 9th ed., Hanke and Wichern. Pearson/Prentice Hall, Inc, ISBN: 139780132301206 • Statistics, data analysis and decision modelling, Evan, James R., Pearson Prentice Hall, 2007

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	0	0	0
Midterm Examination (1 week)	0	0	0
Final Examination (1 week)	1	2	22
Preparation for Midterm Examination	0	0	0
Preparation for Final Examination	0	0	0
Assignment / Homework / Project	4	25	100
Seminar / Presentation	0	0	0
Total Workload			147
ECTS Credit (Total Workload / 25)			6

Course Code: MAN 629	**Course Name:** QUALITATIVE RESEARCH METHODS		
Level: PhD	**Year:** I	**Semester:** I	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	The purpose of this course is to analyze qualitative research subjects for advanced research studies in social sciences. The course is designed to prepare graduate students to read and comprehend qualitative research publications as well as have them conduct research studies for their own projects/theses.		
Course Objectives	Objective of the course is to give understanding of main concepts in qualitative research methodology such as interviewing, ethnography, case study, grounded theory, observation, sampling, data collection, ethics and publication.		
Course Content	• The case and rational for qualitative research • Interviewing • Ethnography • Single and multiple case study research • Grounded theory • Case study • Observation • Midterm exam	• Designing qualitative research: Defining a problem, selecting a site, and sampling informants • Data collection • Dealing with validity, reliability and ethics • Level of analysis • Strategies and techniques for data analysis • Building theories of qualitative research • Publication of qualitative research	
Teaching Methods Description	• Interactive lectures and communication with students • Project – research proposal	• Problem solving or case studies • Presentations	

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	0 %	Term Paper	20 %
	Project	20 %	Attendance	0 %
	Midterm Exam	20 %	Class Deliverables	0 %
	Presentation	10 %	Final Exam	30 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Understand the development of a qualitative research project 2. Learn how to conduct a qualitative research, collect and analyze data 3. Discuss main research approaches in qualitative research 4. Describe main concepts in qualitative research ethics 5. Acquire and apply skills to write a scientific research publication with qualitative research
Prerequisite Course(s)	- Completion of a graduate level research methodology course
Language of Instruction	English
Mandatory Literature	• Merriam, S. B. (2009). Qualitative Research: A Guide to Design and Implementation. New Jersey: Wiley. • Cresswell, J. W. (2008). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 3rd Edition. Thousand Oaks, CA: Sage.
Recommended Literature	• Corbin, J and Straus, A. (2007). Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory 3rd Edition. Thousand Oaks, CA: Sage

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	0	0	0
Midterm Examination (1 week)	1	2	2
Final Examination (1 week)	1	3	3
Preparation for Midterm Examination	1	10	10
Preparation for Final Examination	1	13	13
Assignment / Homework / Project		50	50
Seminar / Presentation		30	30
Total Workload			153
ECTS Credit (Total Workload / 25)			6

Course Code: MAN 630	**Course Name:** QUANTITATIVE RESEARCH METHODS		
Level: PhD	**Year:** I	**Semester:** I	**ECTS Credits:** 6
Status: Elective	**Hours/Week:** 3		**Total Hours:** 45
Course Description	This course is designed to provide an introduction to statistical methods useful for analyzing data, with specific application to problems of business and economics.		
Course Objectives	The objective of the course is to give students understanding of the fundamentals of uncertainty and risk management, methods for estimation and forecasting, risk and estimation in optimization, and tools of statistical inference. Students are also expected to learn how to use statistics to think critically about real world issues. Statistical methodology and theory will be presented in an applications context. Ultimately, the goal is to provide students with quantitative tools that can be used in the areas of marketing, financial and managerial accounting, corporate finance, and applied operational methods.		
Course Content	• Organizing and Visualizing Data • Numerical Descriptive Measures • Basic Probability • Discrete Probability Distributions • The Normal Distribution and Other Continuous Distributions • Sampling and Sampling Distributions • Confidence Interval Estimation	• Fundamentals of Hypothesis Testing • One-Sample Tests • Two-Sample Tests • Analysis of Variance • Chi-Square Tests and Nonparametric Tests • Simple Linear Regression • Multiple Regression • Time-Series Forecasting & Presenations	
Teaching Methods Description	• Practical Sessions • Presentation	• Assignments • Case Studies	

Assessment Methods Description (%)				
	Quiz	0 %	Lab/Practical Exam	0 %
	Homework	10 %	Term Paper	20 %
	Project	15 %	Attendance	0 %
	Midterm Exam	0 %	Class Deliverables	0 %
	Presentation	15 %	Final Exam	40 %
	Total	**100 %**		

Learning Outcomes	After completion of this course, students should be able to: 1. Describe the steps of the decision-making process and different types of decision-making environments. 2. Make decisions under uncertainty when probability values are not known. Make decisions under risk when probability values are known. 3. Use Excel to set up and solve problems involving decision tables. 4. Develop accurate and useful decision trees. 5. Critically appraise the validity and reliability of quantitative methods and analytical approaches within a research project. 6. Use a range of quantitative analysis methods to summarize and analyze quantitative data.
Prerequisite Course(s)	-
Language of Instruction	English
Mandatory Literature	• Basic Business Statistics: Concepts and Applications, 12th edition (2012), David Levine, Mark Berenson, and Tim Krehbiel, ISBN 10: 0-13-216838-3, ISBN 13: 978-0-13-216838-0 Prentice Hall
Recommended Literature	• Balnaves, Mark, Caputi, Peter (2001), Introduction to Quantitative Research Methods, An Investigative Approach, ISBN: 9780761968047

ECTS (ALLOCATED BASED ON STUDENT'S WORKLOAD)

Activities	**Quantity**	**Duration**	**Workload**
Lecture (15 weeks x Lecture hours per week)	15	3	45
Laboratory / Practice (15 weeks x Laboratory / Practice hours per week)	0	0	0
Midterm Examination (1 week)	0	0	0
Final Examination (1 week)	1	3	3
Preparation for Midterm Examination	0	0	0
Preparation for Final Examination	1	30	30
Assignment / Homework / Project	2	20	40
Seminar / Presentation	2	15	30
Total Workload			148
ECTS Credit (Total Workload / 25)			6