Ευρωπαϊκό Πανεπιστήμιο Κύπρου

LAUREATE INTERNATIONAL UNIVERSITIES

ΣΧΟΛΗ ΘΕΤΙΚΩΝ ΠΙΣΤΗΜΩΝ

ΠΑΡΑΤΗΡΗΣΕΙΣ

για την Έκθεση της Επιτροπής Εξωτερικής Αξιολόγησης του Φορέα Διασφάλισης και Πιστοποίησης της Ποιότητας της Ανώτερης Εκπαίδευσης.

ΓΙΑ ΤΟ ΠΡΟΓΡΑΜΜΑ

«TELECOMMUNICATIONS ENGINEERING (M.Sc.)»

23 Οκτωβρίου 2016

Παρατηρήσεις για την Έκθεση της Επιτροπής Εξωτερικής Αξιολόγησης

«TELECOMMUNICATIONS ENGINEERING (M.Sc.)»

Η Σχολή Θετικών Επιστημών του Ευρωπαϊκού Πανεπιστημίου Κύπρου ευχαριστεί θερμά το ΔΙ.Π.Α.Ε. και την Επιτροπή Αξιολόγησης για την αξιολόγηση του μεταπτυχιακού μας προγράμματος «Telecommunications Engineering (M.Sc.)». Τα εποικοδομητικά σχόλια και οι σημαντικές εισηγήσεις της Επιτροπής είναι για μας εργαλείο βελτίωσης και αναβάθμισης του περιεχομένου του προγράμματος.

Θέλουμε να διαβεβαιώσουμε την Επιτροπή ότι λαμβάνουμε πολύ σοβαρά υπόψη **όλες** τις εισηγήσεις που περιλαμβάνονται στην έκθεσή της, τις οποίες έχουμε ήδη υλοποιήσει, όπως παρατίθεται πιο κάτω, αναλυτικά.

Σύσταση Επιτροπής:

1. **Η Επιτροπή διατηρεί κάποιες επιφυλάξεις σχετικά με τα μαθησιακά αποτελέσματα του προτεινόμενου προγράμματος για την εκπαίδευση και κατάρτιση τηλεπικοινωνιακών μηχανικών. Οι επιφυλάξεις αυτές σχετίζονται με το προτεινόμενο πρόγραμμα σπουδών και την εργαστηριακή εκπαίδευση των φοιτητών. Πιο λεπτομερή σχόλια και προτάσεις θα δοθούν στη συνέχεια.**

Υλοποίηση:

Για τη συμβατότητα των μαθησιακών αποτελεσμάτων του προγράμματος με το περιεχόμενο γίνονται αλλαγές όπως εμφανίζονται στο **Παράρτημα Ι**:

Σύσταση Επιτροπής:

2. **Ως γενική παρατήρηση, προτείνεται η περιγραφή του περιεχομένου των μαθημάτων να τροποποιηθεί ως εξής**
   • να δίδεται ιδιαίτερη έμφαση στα αμιγώς μεταπτυχιακά αντικείμενα,
   • να μην υπάρχουν επικαλύψεις μεταξύ υποχρεωτικών μαθημάτων,
   • η ύλη των υποχρεωτικών μαθημάτων και των μαθημάτων Foundations να είναι διακριτή.

Υλοποίηση:

Θεωρούμε εξαιρετικά χρήσιμη τη παρατήρηση της Επιτροπής, και για το λόγο αυτό έχουμε προχωρήσει στις εξής τροποποιήσεις στο περιεχόμενο των σχετικών μαθημάτων.

- Στο μάθημα ECE611 Data Communications and Networking, συμπτύχθηκε η εισαγωγή και προστέθηκαν στην ύλη δίκτυα όπως RAN / WRAN.
- Στο μάθημα ECE612 Digital Communications προστέθηκε η ύλη σχετικά με τεχνικές MIMO όπως επίσης εμπλουτίστηκε και η βιβλιογραφία.
- Στο μάθημα ECE621 RF and Microwave Engineering συμπτύχθηκαν κάποια κομμάτια, αφαιρέθηκε η ύλη για ABCD matrices, coaxial cables και προστέθηκε η ύλη για S-parameters και metamaterials. Επίσης προστέθηκε η ύλη για active devices (RF diodes, BJT / HBT / MOSFET etc.) ενώ ταυτόχρονα αφαιρέθηκε το κομμάτι αυτό από το ECE622 Antennas, EM Devices and Propagation για να μην υπάρχει επικάλυψη.
- Στο μάθημα ECE622 Antennas, EM Devices and Propagation, συμπτύχθηκε η εισαγωγή στις κεραίες, και προστέθηκε η ύλη για tropospheric propagation.
- Το μάθημα Master Thesis συνενώθηκε με το Research Methods του οποίου η ύλη θα καλύπτεται μέσα στο Master Thesis με διαλέξεις.
- Στη θέση του μαθήματος ECE613 Research Methods μπήκε το Statistical Analysis and Quality Control.
- Στο μάθημα ECE623 Advanced Mobile Radio Communications προστέθηκαν τα multipath effects τα οποία εμφανίζονταν στο ECE622 Antennas, EM Devices and Propagation. Επίσης προστέθηκαν στη βιβλιογραφία τα ITU recommendations / models.

Δείτε τις πιο πάνω τροποποιήσεις στις επισυναπτόμενες περιγραφές των σχετικών μαθημάτων (Παράρτημα Ι).

Σύσταση Επιτροπής:

3. **Επιπλέον, η Επιτροπή προτείνει την ευρεία εισαγωγή εργαστηριακών ασκήσεων (τουλάχιστον σε περιβάλλον λογισμικού). Η Επιτροπή θεωρεί ότι η εισαγωγή (έστω και περιορισμένου αριθμού) εργαστηριακών ασκήσεων σε κατάλληλο hardware (π.χ., Software Defined Radios) θα δώσει σημαντικό συγκριτικό πλεονέκτημα στο προτεινόμενο πρόγραμμα.**

Υλοποίηση:

Συμφωνούμε με το σχόλιο της Επιτροπής για την ανάγκη εισαγωγής εργαστηριακών ασκήσεων σε περιβάλλον λογισμικού. Για το σκοπό αυτό έχει εισαχθεί πρόνοια εργαστηριακών ασκήσεων στις περιγραφές των πιο κάτω μαθημάτων:

- Στο ECE611 Data Communications and Networking, ενσωματώθηκαν στην περιγραφή, εργαστηριακές ασκήσεις σε MATLAB / NS2 / NS3 / OPNET ανάλογα με τις εργασίες που θα επιλέξει ο καθηγητής.
- Στο ECE612 Digital Communications ενσωματώθηκαν στην περιγραφή, εργαστηριακές ασκήσεις σε MATLAB ανάλογα με τις εργασίες που θα επιλέξει ο καθηγητής.

- Στο ECE621 RF and Microwave Engineering ενσωματώθηκαν στην περιγραφή, εργαστηριακές ασκήσεις σε MATLAB / CST / RF.Spice A/D κλπ. (e.g. RF amplifier design exercise) ανάλογα με τις εργασίες που θα επιλέξει ο καθηγητής.
- Στο ECE622 Antennas, EM Devices and Propagation, ενσωματώθηκαν στην περιγραφή, εργαστηριακές ασκήσεις (e.g. design of phased array antennas) σε MATLAB / CST / RF.Spice A/D κλπ. ανάλογα με τις εργασίες που θα επιλέξει ο καθηγητής.
- Στο ECE623 Advanced Mobile Radio Communications ενσωματώθηκαν στην περιγραφή, εργαστηριακές ασκήσεις σχετικά με το μάθημα σε MATLAB.

Δείτε τις πιο πάνω τροποποιήσεις στις επισυναπτόμενες περιγραφές των σχετικών μαθημάτων (Παράρτημα Ι).

Συμφωνούμε επίσης με το σχόλιο της Επιτροπής για το ότι η εισαγωγή εργαστηριακών ασκήσεων με hardware θα ενισχύσει την ανταγωνιστικότητά του προγράμματος. Για το σκοπό αυτό, έχουμε ήδη προβλέψει ειδικό κονδύλι στον προϋπολογισμό της Σχολής Θετικών επιστημών για την αγορά κατάλληλου εξοπλισμού όπως USRP2. Ο εξοπλισμός αυτός θα χρησιμοποιηθεί κυρίως στα πιο κάτω μαθήματα:

ECE627 Digital Receivers
ECE690 Master Thesis

Σύσταση Επιτροπής:

4. **Η Επιτροπή προτείνει τη συμπλήρωση της περιγραφής των μαθημάτων με ενδεικτικές εργασίες (assignments), οι οποίες, πιθανώς, σε συνεργασία με τη βιομηχανία, θα ενισχύουν τα μαθησιακά αποτελέσματα του προτεινόμενου προγράμματος.**

Υλοποίηση:

Η συμπλήρωση της περιγραφής των μαθημάτων με συγκεκριμένες, κάθε φορά, εργασίες (assignments) θα γίνεται από τον διδάσκοντα καθηγητή του μαθήματος κατά τον σχεδιασμό του διαγράμματος του μαθήματος (course outline) πριν την έναρξη του ακαδημαϊκού εξαμήνου.

Σύσταση Επιτροπής:

5. **Η Επιτροπή εισηγείται τις πιο κάτω αλλαγές στο curriculum του προγράμματος και την ύλη συγκεκριμένων μαθημάτων:**

   - **Το μάθημα ECE613 Research Methods and Statistical Analysis να διασπαστεί στα μαθήματα (1) Research Methods (μάθημα επιλογής ή σεμινάριο) και (2) Statistical Analysis and Quality Control**
   - **Την εισαγωγή μαθήματος επιλογής Θεωρία Πληροφορίας και Κωδίκων,**
   - **Την εισαγωγή μαθήματος επιλογής Ψηφιακοί Δέκτες,**

- **Την εισαγωγή μαθήματος επιλογής Προχωρημένες Τεχνικές Επεξεργασίας Σήματος,**
- **Την εισαγωγή μαθήματος επιλογής Οπτικές Επικοινωνίες,**
- **Την τροποποίηση της ύλης του μαθήματος ECE625 Satellite System Engineering ώστε να δίδεται ιδιαιτερη έμφαση στην επιστήμη του μηχανικού τηλεπικοινωνιών.**

Υλοποίηση:

Η ύλη του μαθήματος ECE613 έχει διαχωριστεί σε δύο μέρη. Η ύλη που σχετίζεται με τον τομέα research methods θα διδαχθεί ως μέρος της ύλης του μαθήματος Master Thesis, και η ύλη του μαθήματος Statistical Analysis θα ενταχθεί στη διδασκαλία του νέου βασικού μαθήματος ECE613 Statistical Analysis and Quality Control το οποίο και θα διδάσκεται το πρώτο εξάμηνο.

Συμπληρωματικά, έχουν εισαχθεί στο πρόγραμμα σπουδών (curriculum), σύμφωνα με τις εισηγήσεις της Επιτροπής, τα ακόλουθα μαθήματα επιλογής:

- ECE626 Information Theory and Coding / Θεωρία Πληροφορίας και Κωδίκων,
- ECE627 Digital Receivers / Ψηφιακοί Δέκτες,
- ECE628 Advanced Signal Processing / Προχωρημένες Τεχνικές Επεξεργασίας Σήματος,
- ECE629 Optical Communications / Οπτικές Επικοινωνίες

Δείτε τις πιο πάνω τροποποιήσεις στις επισυναπτόμενες περιγραφές των σχετικών μαθημάτων (Παράρτημα Ι).

Σύσταση Επιτροπής:

Τέλος, σχετικά με την εισήγηση της Επιτροπής για **τροποποίηση της ύλης του μαθήματος ECE625 Satellite System Engineering ώστε να δίδεται ιδιαίτερη έμφαση στην επιστήμη του μηχανικού τηλεπικοινωνιών** παρακαλώ σημειώστε**:**

Υλοποίηση:

Ο σκοπός του συγκεκριμένου μαθήματος είναι να δώσει στον μηχανικό τηλεπικοινωνιών επιπρόσθετες βασικές γνώσεις σχεδιασμού, κατασκευής και λειτουργίας δορυφορικών συστημάτων, έτσι ώστε να είναι σε θέση εργαστεί και να συνεργαστεί για την υλοποίηση διαφόρων έργων σχετικά με δορυφορικά συστημάτων. Το μάθημα αυτό προήλθε κατόπιν εισηγήσεως του Industrial Advisory Board. Συμφωνούμε όμως ότι πρέπει να υπάρχει και η απαραίτητη εκπαίδευση σε θέματα Satellite Communications που είναι άμεσα συνυφασμένα με την επιστήμη του μηχανικού τηλεπικοινωνιών. Γι' αυτό το λόγο, προστέθηκε το μάθημα ECE630 Satellite Communications του οποίου το περιεχόμενο εστιάζει στο θέμα των τηλεπικοινωνιών (από δορυφόρους). Πιστεύουμε πως με τα δύο μαθήματα επιλογής ECE625 και ECE630, οι φοιτητές μας θα είναι πιο καταρτισμένοι / εξειδικευμένοι σε θέματα Satellite Communications.

Σύσταση Επιτροπής:

6. **Η Επιτροπή εκτιμά ότι, για την επιτυχή υλοποίηση των παραπάνω προτάσεων, η ομάδα διδασκόντων του προγράμματος θα πρέπει, πιθανώς, να ενισχυθεί με διδάσκοντες με τα κατάλληλα γνωστικά αντικείμενα**.

Υλοποίηση:

Η Σχολή Θετικών Επιστημών υλοποιεί ένα πρόγραμμα συνεχούς ενίσχυσης του επιστημονικού της προσωπικού ανάλογα με τις εκάστοτε ανάγκες των προγραμμάτων σπουδών. Μόλις το πρόγραμμα Telecommunications Engineering MSc εγκριθεί, θα πραγματοποιηθούν οι αναγκαίες πρόσθετες προσλήψεις για την κάλυψη των τυχόν διδακτικών αναγκών.

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Δρ Χρήστος Δημόπουλος, Αναπληρωτής Καθηγητής
Κοσμήτορας
Σχολή Θετικών Επιστημών

European University Cyprus

LAUREATE INTERNATIONAL UNIVERSITIES

Παράρτημα Ι

«TELECOMMUNICATIONS ENGINEERING (M.Sc.)»

GENERAL OBJECTIVES:

- To provide education leading to an academic degree, namely a Master of Science in Telecommunications Engineering.
- To develop the student's capacity to think, write and speak effectively and creatively.
- To develop the student's analytical, decision-making and communication competencies together with those qualities of self-reliance, responsibility, integrity and self-awareness which will promote personal achievement and contribution to organizations.
- To obtain a good grounding in advanced topics in Telecommunications Engineering through the core subjects and attain specialization through the elective courses.
- To provide the student with the advanced skills, necessary for further advancement in an academic and/or professional career.

SPECIFIC OBJECTIVES:

- To intensify and deepen knowledge gained in the Bachelors programme in Computer / Electrical / Electronic Engineering.
- To prepare students for a lifetime career in industry, government and various institutions in the area of Telecommunications Engineering, by establishing a foundation for lifelong learning and development.
- To ensure a learning experience which will provide students with the theoretical background and the applied know-how for engineers in Telecommunications to enter any sector of the industry as key personnel.
- To promote wired and wireless communications in Cyprus through education, research and practical experience.

- To expose students to the area of scientific research and independent study and to demonstrate creativity and conduct original research work through the completion of the M.Sc. thesis in a specialized topic in the area of Telecommunications Engineering.
- To analyse and specify the software and hardware requirements appropriate for a solution to a problem in the area of Telecommunications Engineering.
- To design, implement, and evaluate solutions to Telecommunications Engineering problems, according the desired specifications.
- To apply mathematical foundations and engineering principles during the modelling, design, and evaluation of telecommunications systems, in a way that demonstrates comprehension of the trade-offs involved in design choices.

LEARNING OUTCOMES:

Upon successful completion of this program, the students should be able to:

- State and identify concepts relating to data communications; communication protocols and layered protocol architecture and describe the different network topologies.
- Compare different protocols in terms of their throughput, error detection and correction, reliability and stochastic or deterministic channel allocation.
- Describe the underlying principles of transmission, detection and explain the basic principles of digital modulation and demodulation for wireless systems.
- Define the engineering principles of wireless transmission, cellular systems and the different cellular/mobile systems and analyse and calculate the path loss, fading profiles and effects of multi-path propagation.
- Generate appropriate orthogonal codes, on the basis of user demand, service requirements and fairness of resource allocation, for use in FDD and TDD UMTS systems.
- Explain the mathematical principles behind RF and microwave devices and analyze the EM transmission characteristics of planar-lines and waveguides.
- Perform scattering parameter analysis of RF and microwave networks containing passive distributed components and design and analyze microwave / RF oscillators / mixers / filters / end-to-end microwave / RF communication links.

- Recognise the uses of antennas, RF components and sources and analyse and evaluate their performance. Design antenna elements in MATLAB and / or CST.
- Assess the propagation of electromagnetic signals in physical environments perform simple path loss calculations.
- Demonstrate ability to conduct in-depth research, both individually as well as in teams, in a specific area of Telecommunications as well as manage project. Recognise and describe legal, social or ethical obligations.
- Construct efficient codes for data on imperfect communication channels and describe possible implications and evaluate performance of various coding techniques over fading channels.
- Describe, design and implement the typical architecture of a digital receiver.
- Describe the operation principles and technology of optical fibre networks and design optical transmitter / receiver and identify possible sources of loss.
- Recognise and evaluate modern satellite multiple access, modulation and coding schemes and simulate satellite communication links.
- Describe and compare different models of parallel and distributed computing, basic techniques for designing algorithms in these models and write parallel programs using them.
- Utilize advance algorithmic techniques such as approximation and randomization techniques in order to provide algorithmic solutions of proved guarantee performance for the problems that are hard to solve.
- Apply fundamentals of discrete probability theory, the theory of Markov chains, randomized data structures, the probabilistic method, counting techniques and graph theory for modeling, design and analysis of algorithmic problems and solutions.

STRUCTURE OF THE PROGRAM OF STUDY

DEGREE REQUIREMENTS	ECTS
Compulsory courses	52
Elective courses	16
Master Thesis	22
Total ECTS	**90**

DEGREE REQUIREMENTS	ECTS
Compulsory courses (52 ECTS)	**52**
ECE611 - Data Communications and Networking	8
ECE612 - Digital Communications	8
ECE613 - Statistical Analysis and Quality Control	6
ECE621 - RF and Microwave Engineering	10
ECE622 - Antennas, EM Devices and Propagation	10
ECE623 - Advanced Mobile Radio Communications	10
Elective courses 16 (ECTS) **(Students choose two from the following courses)**	**16**
ECE624 – Special Topics in Telecommunication Engineering	8
ECE625 – Satellite Systems Engineering	8
ECE626 – Information Theory and Coding	8
ECE627 – Digital Receivers	8
ECE628 –Advanced Signal Processing	8
ECE629 – Optical Communications	8
ECE630 – Satellite Communication Systems	8
ECE631 – Distributed Computing and Parallel Processing	8
ECE632 – Approximation and Randomized Algorithms	8
ECE633 – Graph Theory & Applications in Networks	8
Master Thesis	**22**
ECE690 – Master Thesis	22
Total ECTS	**90**

Course Title	Data Communications and Networking				
Course Code	ECE611				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 1st Semester				
Teacher's Name	Katerina Papanikolaou				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course provides an overview of the broad and constantly emerging field of data communications and computer networks. Data communication is discussed as the necessary tool for understanding wired / wireless communication networks.				
Learning Outcomes	Upon succesful completion of this course, students should be able to: • State and identify concepts relating to data communications; communication protocols and layered protocol architectures. • State and interpret protocol communication standards like OSI/RM and TCP/IP as used in computer networking and internetworking. • Compare different protocols in terms of their throughput, error detection and correction, reliability and stochastic or deterministic channel allocation. • Describe different network topologies, physical components and their characteristics such as delay or round-trip-time. • Recognize and explain data transmission fundamentals and types of media (both wired and wireless). • Define, explain and exemplify concepts related to Local Area Networks (both wired and wireless); their topologies and protocols; their types and transmission technologies. • Describe, explain and classify types of security attacks; types and algorithms of encryption; security functionality in IP versions 4 and 6.				
Prerequisites	None	Co-requisites	None		
Course Content	Introduction: Communication systems, entities and components. Computer networks as communication system; their topologies and				

	types. Communication protocols, layered communications and protocols architectures. The OSI RM and TCP/IP standards Data communication systems; transmission, impairments and media, Data transmission basics; frequency concepts, bandwidth, spectrum; data rate and bandwidth. Transmission media and impairments for both wired (UTP, STP, Coaxial, Fiber) and wireless (Microwave, Radio, Infrared). Signal encoding techniques; analog-to-digital (and visa-versa) data-to-signal conversion Application Layer: Client-Server and Peer-to-peer architectures, Principles of Network Applications, the Web and HTTP, Cookies, Web caching, FTP, DNS, HTTP, Email, POP3, SMTP, IMAP, exchange, P2P applications, Sockets. Transport Layer: Multiplexing and De-Multiplexing, Connection-less transport UDP, principles of reliable data transfer, Connection-oriented transport TCP, flow control, congestion control. Network Layer: Forwarding and Routing, Routing Algorithms, Distance Vector, Link State, Hierarchical, Broadcast, Multicast. Construction of Tables, Minimum Spanning Trees, IP protocol and routers Data Link Layer and Medium Access Control: Synchronous & asynchronous transmission error detection and correction, multiple access protocols: Aloha, Slotted Aloha, CSMA, CSMA/CD, Ethernet, Switches. Flow control: Stop-and-wait, Sliding-window, Automatic Repeat Request. The High-level Data Link Control protocol: modes, frame types and operation. Frequency Division Multiplexing, Synchronous and Statistical Time Division Multiplexing, multiplexing applications (CATV, ADSL) Local area networks; wired and wireless: LAN topologies, protocols and the IEEE 802.XX standards; LAN interconnection, bridges, hubs, switches. Ethernet versions. Wireless LANs, RANs, WRANs: applications/types and transmission technologies. Cloud computing, environment, architecture, type of services, resource management in cloud computing. Network security: Requirements; types of attacks; symmetric and asymmetric encryption techniques and their algorithms; Secure Socket Layer; IPv4 and IPv6 security; wireless protected access. Lecture by invited experts from the network related local industry. Discussion normally focuses on current network infrastructure design / implementation challenges, IP issues, business, commercial and financial aspects and on recent/future developments. A number of assignments will be allocated, both survey based and simulation based using software tools such as MATLAB / NS2 / NS3/

	OPNET / etc.
Teaching Methodology	Face–to–face
Bibliography	Stallings, William, DATA AND COMPUTER COMMUNICATIONS, International edition, Prentice Hall Kurose and Ross, Computer Networking, Pearson, Laetst Edition. A. Tanenbaum, COMPUTER NETWORKS, Pearson Prentice Hall U. Black, DATA COMMUNICATIONS AND DISTRIBUTED SYSTEMS, Pearson Prentice Hall Journal: ACM Communications Journal: IEEE Transactions on Networking Halsall, F., DATA COMMUNICATIONS, COMPUTER NETWORKS AND OSI, Addison-Wesley William A. Shay, UNDERSTANDING DATA COMMUNICATIONS AND NETWORKS, Thomson Learning (Course) Michael A. Gallo, William M. Hancock, COMPUTER COMMUNICATIONS AND NETWORKING TECHNOLOGIES, Thomson Learning (Course) Marion Cole, INTRODUCTION TO TELECOMMUNICATIONS: VOICE, DATA AND THE INTERNET, Prentice Hall Wayne Tomasi, INTRODUCTION TO DATA COMMUNICATIONS AND NETWORKING, Prentice Hall Regis J. Bates, Donald W. Gregory, VOICE AND DATA COMMUNICATIONS HANDBOOK, McGraw-Hill Stallings William, BUSINESS DATA COMMUNICATIONS Prentice Hall
Assessment	Examinations 60% Assignment(s) 40% 100%
Language	English

Course Title	Digital Communications				
Course Code	ECE612				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 1st Semester				
Teacher's Name	Katerina Papanikolaou				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course introduces fundamental concepts of modern digital communications, particularly in the context of digital transmission techniques, emphasizing important concepts and features of digital radio systems.				
Learning Outcomes	Upon succesful completion of this course students should be able to: • Describe the underlying principles of transmission, detection, and coding of digital signals. • Explain the basic principles of digital modulation and demodulation for wireless systems. • Analyse digital communication methods and applications in practical systems. • Recognize various detection techniques for base-band signals. • Classify various digital modulation techniques. • Evaluate the performance of various radio systems.				
Prerequisites	None	Co-requisites	None		
Course Content	Signals and Spectra: Digital Communication Signal Processing. Classification of Signals. Spectral Density. Autocorrelation. Random Signals. Signal Transmission through Linear Systems. Bandwidth of Digital Data. Formatting and Baseband Modulation: Baseband Systems. Textual Data (Character Coding). Symbols, Characters and Messages. Analog Information and message corruption. Pulse Code Modulation. Baseband Modulation. Correlative Coding. Uniform and Non-uniform Quantization. Baseband Demodulation / Detection: Signals and Noise. Detection of Binary Signals in Gaussian Noise. Intersymbol				

	Interference. Equalization. Bandpass Modulation, demodulation and detection: Digital Bandpass Modulation Techniques. Gaussian Noise, detection of signals. Complex Envelope. Coherent and Non-coherent detection. Binary system error performance. M-ary Signaling and Performance. Symbol Error Performance for M-ary Systems (M>>2). Channel Coding: Waveform Coding, error control. Structured Sequences. Linear Block Codes. Error-Detecting and Correcting Capability. Usefulness of the Standard Array. Cyclic Codes. Convolutional Encoding / Encoder Representation. Properties of Convolutional Codes. Reed-Solomon Codes. Interleaving and Concatenated Codes. Coding and Interleaving, Turbo Codes. Modulation and Coding Trade-Offs: Communications System Design. Shannon-Hartley Capacity Theorem and Nyquist Minimum Bandwidth. Error Probability and Bandwidth Efficiency Plane. Bandlimited Channels. Trellis-Coded Modulation. Defining, Designing, and Evaluating Systems. Spread-Spectrum Techniques: Spread-Spectrum Overview. Pseudo-noise Sequences. Direct-Sequence Spread-Spectrum Systems. Frequency Hopping Systems. Synchronization. Jamming Considerations. Commercial Applications. Source Coding: Sources. Amplitude Quantizing. Differential Pulse-Code Modulation. Adaptive Prediction. Block Coding. Transform Coding. Source Coding for Digital Data. Examples of Source Coding. FSK, MSK, GMSK: power and bandwidth efficiencies, Spread spectrum signaling Fading Channels: Mobile-Radio Propagation characterization based on fading channels. Signal Time-Spreading and time variance of the channel. Mitigating the degradation effects of fading. Mitigating the effects of fading. Multiple Input Multiple Output (MIMO): transceiver design, MIMO space-time processing algorithms, beamforming and transmitter preprocessing, relay/cooperative communications, etc. Lecture by invited experts from the local R&D industry in the area of Digital Communications. Discussion normally focuses on communication related issues, business, commercial and financial aspects and on recent/future developments. A number of assignments will be allocated both survey based and simulation based using software tools such as MATLAB.

Teaching Methodology	Face–to–face
Bibliography	1. B. Sklar, Digital Communications Fundamentals and Applications, Latest Edition, Prentice Hall. 2. R.E. Ziemer, and R.L. Petersons, Introduction to Digital Communication, Latest Edition., Prentice Hall. 3. I.A. Glover and P.M. Grant, Digital Communications, Latest Edition, Pearson Education Prentice Hall. 4. S. Haykin S, Communication Systems, Wiley, Latest Edition. 5. J. G. Proakis, “Digital Communications” Latest Edition, McGraw-Hill 6. A. Lapidoth: A Foundation in Digital Communication, Cambridge University Press, Latest Edition
Assessment	Examinations 40% Assignment(s) 60% 100%
Language	English

Course Title	Statistical Analysis and Quality Control				
Course Code	ECE613				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 1st Semester				
Teacher's Name	Konstantinos Katzis / Pieris Chourides				
ECTS	6	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course is designed to help students develop a better appreciation of the vital role of total quality management in modern firms and learn its basic concepts and tools. The practical aspects of adopting and implementing quality standards are considered through the analysis of case studies in Telecommucniation industry. It provides students with practical knowledge of environmental assessment tools and the process of adoption of environmental standards through analysis of cases and other assignments. Students will acquire the necessary skills to enable them to work with probabilities, model engineering data using some of the more common probability distributions and evaluate confidence intervals for parameters. They also apply regression and correlation methods to straight line data, design one and two-stage acceptance sampling plans and be aware of ways of describing and evaluating failure time data through examples motivated by telecommunication engineering related applications using real data from well known standards, recommendations and models. The class will follow a seminar and discussion/workshop format.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Use various resources to carry out a literature search. • Structure and format the project to agreed conventions. • Design, execute, interpret and report results from empirical research projects • Develop transferable skills including collaborative work, peer-review and reflection (self-assessment). • Identify statistical problems of multivariate dimension, with special emphasis in telecommunication engineering. • Describe multivariate datasets				

	• Recognise and describe multivariable statistical models • Apply statistical models for regression analysis, and ANOVA models, applied to real data of telecommunication engineering • Ability to model time series data, estimate their parameters and apply it to real problems of signal processing and telecommunications • Design, execute, interpret and report results from simulations / experiments using MATLAB. • Manage a project and explain the relevant techniques and tools needed in order to complete it successfully on time and within budgeted resources.		
Prerequisites	None	Co-requisites	None
Course Content	**The nature of research:** Definitions and types of research; research process; topic selection and scope; feasibility and value. **The literature search:** Sources of information; differentiating between types of sources; primary, secondary and tertiary sources; using the library and digital databases to conduct efficient literature reviews; searching the Internet; role of the supervisor. **Quality Management:** Evolution of Quality and Early Theories of Quality Management, The Cost of Quality –The Voice of the Customer / Market, Managing Quality Improvement - Teams and Projects, Managing Supplier Quality in the Supply Chain, Quality Management Systems, Quality Management - Measures of Organizational Success, Designing Quality Services. **Project management:** Methods, techniques and tools for research design, and data collection. **Analysis and synthesis:** Statistical Analysis: Review of basic concepts, point estimation, statistical inference. Sample statistics and their distribution, estimation and estimators. Methods of moments and of maximum likelihood. Confidence intervals and hypothesis testing. Distribution and density functions, distribution fitting, central limit theorem, graphical methods, goodness of fit chi-square test, transformations. Comparison of populations, comparison of two means from independent /paired samples.		

	Comparison of two variables from normal populations. The multiple regression model, simple and multiple regression. Inference in the regression model. Time series analysis. Applications in telecommunication engineering. **Presentation of research findings:** Project structure; conventions on citation and quotations; style of writing a report. **Quality Policies, Standards and Recommendations in Telecommunications:** Quality policies, quality organization and quality planning, acceptance sampling, reliability, failure rates, standards and certification. ITU Models ITU Models / Recommendations R-REC: F (Fixed Services), M (Mobile), P (Radiowave Propagation), SF (Frequency Sharing), SM (Spectrum Management) and T-REC: K , O. Also recommendations from OFCOM, FCC and ETSI. **Course Project** The student will write a technical report on a related subject provided by the instructor. The subject can be interference analysis, link budget, design requirements analysis and specification as well as the implementation of simulation model to generate useful data for further processing.
Teaching Methodology	Face to face
Bibliography	W. Mendenhall W and T. Sincich, Statistics for Engineering and the Sciences, Latest Edition, Prentice Hall E. G. Schilling and D. V. Neubauer, Acceptance Sampling in Quality Control, Latest Edition C. Chatfield, Statistics for Technology, Latest Edition, Chapman & Hall R. E. Walpole, R. H. Myers, S. L. Myer and K. E. Ye, Probability and Statistics for Engineers and Scientists, Latest Edition, Pearson R. Johnson, Miller & Freunds Probability and Statistics for Engineers, Latest Edition, Pearson J. L. Devore, Probability and Statistics for Engineering and the Sciences, Latest Edition, Thomson R. D. De Veaux, P. F. Velleman and D. E. Bock, Stats: Data and Models, Latest Edition, Pearson

	TL9000:2016 REQUIREMENTS HANDBOOK. Goetsch D.L and Davis S.B (2010) Quality Management for organizational Excellence – Introduction to Total Quality, International Edition, Pearson Education. J. Zobel., WRITING FOR COMPUTER SCIENCE, Springer. W. Navidi, Statistics for Engineers and Scientists, McGraw-Hill Science/Engineering/Math; Latest Edition. Statistical Methods for Engineers, by Geoffrey Vining and Scott M. Kowalski, Thomson, Brooks/Cole, Latest Edition. J.G. Paradis, M., Zimmerman,THE MIT GUIDE TO SCIENCE AND ENGINEERING COMMUNICATION, The MIT Press. D. Madsen, SUCCESSFUL DISSERTATIONS AND THESES., A GUIDE TO GRADUATE STUDENT RESEARCH FROM PROPOSAL TO COMPLETION, Jossey Bass. T. Cornford, S. Smithson, PROJECT RESEARCH IN INFORMATION SYSTEMS., A STUDENT'S GUIDE, Macmillian ITU Models / Recommendations www.itu.int/pub/R-REC - F (FIXED SERVICES), M (MOBILE), P (RADIOWAVE PROPAGATION), SF (FREQUENCY SHARING), SM (SPECTRUM MANAGEMENT) and www.itu.int/pub/T-REC K , O
Assessment	Examinations 40% Project/Assignments 60% 100%
Language	English

Course Title	RF and Microwave Engineering				
Course Code	ECE621				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 2nd Semester				
Teacher's Name	Konstantinos Katzis				
ECTS	10	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course defines and demonstrates the analytic techniques employed in microwave theory and the design. It provides an overview of Maxwell's field theory with respect to high-frequency radiation, propagation and circuit phenomena. It discusses topics related to the subject such as radiofrequency (RF) and microwave (MW) propagation modes. Topics such as Smith Chart, scattering parameter analysis, matching networks, transmission line aspects, microwave filters, power flow relations, unilateral and bilateral amplifier designs, stability analysis, oscillators circuits, mixers and microwave antennas for wireless communication systems are also presented.				
Learning Outcomes	Upon succesful completion of this course students should be able to: • Explain the mathematical principles behind RF and microwave devices. • Analyse EM transmission characteristics of planar-lines and waveguides. • Analyse RF and microwave networks containing passive distributed components. • Perform Scattering parameter analysis of RF networks. • Use Smith Chart to perform impedance matching and other advanced microwave/RF system design. • Design and analyze microwave/RF oscillators / mixers / filters. • Design and analyze end-to-end microwave/RF communication links.				
Prerequisites	None		Co-requisites	None	
Course Content	Introduction: RF/MW engineering. Fundamental Equations:				

	Maxwell's equations, wave equations and power relations. Transmission line theory and Waveguides: The Lumped-Element Circuit Model for a Transmission Line, Field Analysis of Transmission Lines and Terminated Lossless Transmission Line. Loaded transmission line, lambda quarter transformer, impedance transformation. General solution to Maxwell's equation, TEM, TE, TM modes, Rectangular - Circular waveguide. Striplines and micro-striplines. Smith Chart Bilinear transformation, Z-Chart and Y-Chart representation, ZY Chart, Load impedance transformation. Power flow considerations: Generator and load mismatch, input power and power absorbed by the load, return and insertion loss calculations. Microwave Networks Analysis: Impedance and Equivalent Voltages and Currents, impedance and admittance matrices, scattering matrix, dual port networks, chain, hybrid. Series and parallel connections and conversations. Computations using Simulators. Scattering Parameters: Definition of S-parameters for n-port networks, S-parameters of source and load mismatching. Impedance Matching and Tuning: L-type Matching networks, Forbidden region, Quality factor computations. Matched and mismatched RF filter. Directional Couplers and Power Dividers: Multiport devices (odd/even analysis), Wilkinson and Lange power dividers, Branch line couplers. Microwave Filter Design / Implementation: Periodic structures, standard low pass design, Butterworth, and Chebyshev design, Scaling to high / bandpass / bandstop design. Scaling from lumped to distributed elements, Kuroda's identities. Coupled filter concepts Microstrip lines, implementation. Active Devices: RF diodes and BJT/ HBT/ MOSFET/ RFCMOS/ HEMT transistors and their application in amplifiers and oscillators , S-parameter extraction. Gain and Stability Analyses: Power flow, Transducer gain definitions, Stability considerations (Rollett factor), Input and output stability circles. Metamaterials: Basic properties, 2D – 3D metamaterial structures, artificial transmission lines as one dimensional metamaterials, applications of metamaterials in microwaves Noise Analysis: Noise sources, Two-port noise analysis, Noise figure, Non-linear distortion.

	Amplifier Design: Small signal design with matching networks, Nonlinearity, Dual tone test, Broadband Amplifiers, Negative feedback design, Balanced amplifier, Traveling wave amplifier, Power Amplifiers. Oscillator Design: Barkhausen criterion, Phase noise, Oscillation stability, Loading and matching strategies. Mixer Design: Performance characteristics, Active mixer. Business case study and lecture: Lecture by invited experts from the mobile industry. Discussion normally focuses on RF / Microwave engineering related issues, business, commercial and financial aspects and on recent/future developments. A number of assignments will be allocated: survey based, simulation based using software tools such as MATLAB / RF.Spice A/D / CST / Genesys RF/ heywhatsthat / Microwave Synthesis and Simulation / etc as well as practical (amplifier design exercise).
Teaching Methodology	Face–to–face
Bibliography	R. Ludwig, G. Bogdanov, RF Circuit Design: Theory and Practice, Latest Edition, Prentice Hall. D.M. Pozar, Microwave Engineering, Addison-Wesley, Latest Edition, Reading, MA. G. Gonzales, Microwave Transistor Amplifiers: Analysis and Design, Latest Edition, Prentice Hall. C. A. Lee and G. C. Dalman, Microwave Devices, Circuits and Their Interaction, latest edition, J. Wiley. A. Rizzi, Microwave Engineering, Passive Circuits, Latest Edition, Prentice-Hall.
Assessment	Examinations 40% Assignment(s) 60% 100%
Language	English

Course Title	Antennas, EM Devices and Propagation				
Course Code	ECE622				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 2nd Semester				
Teacher's Name	Konstantinos Katzis				
ECTS	10	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	Antennas, Electromagnetic Devices and the propagation of radio on the physical layer (PHY) are a fundamental aspect of communications and radars, as well as any other device that radiate electromagnetic waves. The course presents fundamental theory together with techniques for the design, measurement and application of antennas over the radio-frequency (RF) spectrum. It recognizes and classifies EM devices and describe their operation. Propagation of EM waves is expressed through examples.				
Learning Outcomes	Upon succesful completion of this course students should be able to: • List all aperture antenna types. • Analyse and evaluate the performance of antennas, RF components and sources. • Design antenna elements and develop phased array performance models implemented in Matlab and/or CST. • Describe different forms of reflector systems. • Recall antenna numerical analysis principles to analyze antennas. • Recall and apply relevant physical propagation mechanisms for particular frequency bands and propagation environments. • Assess the propagation of electromagnetic signals in physical environments. • Perform simple path loss calculations				
Prerequisites	None	Co-requisites	None		
Course Content	Antenna Fundamentals: antenna concepts and definitions; Friis transmission equation, radar systems, radar cross-section, noise				

	temperature, etc. Radiated fields, Use of potential functions, Far fields, Duality, Reciprocity. Wire antennas, infinitesimal dipole, Poynting's theorem, total power, radiation resistance, short dipole, center-fed dipole, half-wave dipole, antennas over ground, monopole for communications and radar applications including wire antennas, aperture antennas, reflector antennas, small loop antenna, dual sources, loop characteristics, microstrip antennas. Traveling wave antennas, terminations, Vee antenna, rhombic antenna, Yagi-Uda arrays, Log-Periodic antenna, aperture antennas, horn antennas, reflector antennas Phased array antennas. Types of antenna array, feed network design, beam steering and radiation pattern shaping. Performance trade-offs. Effect of radome and FSS covers. System design impact on sensor and communications systems. Electromagnetic Devices. High power Tubes, Klystron, Extended Interaction Klystron, TWT). Ferrite non-reciprocal devices (circulators and isolators). PIN diode switches, modulators and phase shifters. Propagation: Free space propagation, Variation in Mobile Systems, Path loss. Reflection and specular reflection. Fresnel coefficients, polarisation effects. Rough and random surfaces. Refraction and Refractive index. Snell's Law. Sub-path obstacle and knife-edge diffraction. Ionospheric and Tropospheric propagation and scintillation. Fresnel Transmission Coefficients. Lecture by invited experts from the local R&D companies related to the subject. Discussion normally focuses on Antenna design, applications, propagation, EMC effects, and other related issues. Discussion will also focus on business, commercial and financial aspects and on recent/future developments. A number of assignments will be allocated: survey based, simulation based using software tools such as CST / MATLAB / heywhatsthat / RF.Spice A/D / CST / Genesys RF/ Microwave Synthesis and Simulation / etc. as well as practical assignments / projects related to the course such as design of phased array antenna.
Teaching Methodology	Face–to–face
Bibliography	1. Simon R. Saunders, Antennas and Propagation for Wireless Communication, Latest Edition, John Wiley England [ISBN: 978-0-470-84879-1] 2. A.S. Gilmour, Klystrons, Traveling Wave Tubes, Magnetrons,

	Crossed-Field Amplifiers, and Gyrotrons, ISBN: 978-1-60807-184-5, Artech House 3. J.D. Parsons, The Mobile Radio Propagation Channel, Latest Edition, ISBN 0-471-98857-X , John Wiley & Sons 4. M. Golio and J. Golio, RF and Microwave Passive and Active Technologies (The RF and Microwave Handbook, Second Edition) 5. Constantine A. Balanis, Antenna Theory, Analysis and Design, Latest Edition., Wiley, ISBN 0-471-59268-4 6. T. S. Rappaport, Wireless Communications: Principles and Practice , Prentice Hall PTR, Upper Saddle River, NJ
Assessment	Examinations 40% Assignment(s) 60% 100%
Language	English

Course Title	Advanced Mobile Radio Communications				
Course Code	ECE623				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 2nd Semester				
Teacher's Name	Konstantinos Katzis				
ECTS	10	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course looks into the fundamentals of the mobile and wireless communications systems starting with the view of the wireless propagation channel, the wireless environment and the modulation techniques used in wireless systems. GSM, UMTS and LTE are examined from the viewpoints of system architecture, physical layer and system implementation. Physical and logical channel implementation is examined. Issues of network planning, mobile services and business are also considered in the course. Non-mobile systems are described with a focus on the 802.11 (WiFi), 802.15 (Bluetooth and Zigbee), 802.16 (WiMax) and 802.22 WRAN standards.				
Learning Outcomes	Upon succesful completion of this course students should be able to: • Define the engineering principles of wireless transmission, cellular systems and the different cellular/mobile systems. • Analyse and calculate the path loss, fading profiles and effects of multi-path propagation in various cellular environments. • Describe major cellular communication standards. • Describe tradeoffs among frequency reuse, signal-to-interference ratio, capacity, and spectral efficiency. • Define small-scale fading in terms of Doppler spectrum, coherence time, power delay profile, and coherence bandwidth. • Describe FDMA, TDMA, CDMA, SDMA. • Identify the details of channels used in GSM, UMTS and LTE and differentiate between downlink/uplink channels, data/control channels and broadcast/dedicate channels and justify the use of a particular channel for a specific function. • Analyse the effect of various signal deterioration mechanisms and distinguish an appropriate modulation scheme. • Compare the different cellular generations and standards in terms of capabilities, technologies (core and wireless				

	access/physical layer), services, cost, complexity and history.		
Prerequisites	None	Co-requisites	None
Course Content	Introduction: Introduction to current and emerging communication systems: mobile radio, cellular mobile communications, cellular mobile networks, cordless, satellites. Frequency reuse, network planning, cell sectorisation, cell splitting, hand-over, trunking efficiency, grade of service, spectrum auctions, commercial aspects. The wireless and cellular environments, the wireless propagation channel elements of communication systems, large and small-scale effects, path loss, multipath effects, log-normal shadowing, empirical path loss models. Channel models: stochastic, deterministic and empirical. Complex baseband model, linear time-varying channels, narrowband signals and Rayleigh fading, Ricean fading, Doppler shift, Doppler spread with uniform scattering. Fade statistics, coherence time fast / slow channel fading, broadband signals and power delay profile, coherence bandwidth. Flat and frequency-selective fading and their effect on digital transmission. Diversity combining techniques: selection, max-ratio, equal-gain; Multiple access wireless communications; goals and worldwide standards, duplex schemes, physical layer; FDMA, TDMA, CDMA, SDMA, OFDMA and OFDM. Mobile Cellular Systems: GSM: System architecture, the physical layer, Logical and physical channels, Data and services, 2.5 G Basics (HSCSD, GPRS, EDGE, EGPRS). UMTS: System architecture, the physical layer, Coding and channel allocation, Network design, 3.5 and 3.75 systems (HSDPA, HSUPA and HSPA). LTE: System architecture, the physical layer, Coding and channel allocation, Network design. IEEE Wireless Standards: 802.11, 802.15, 802.16, and 802.22 Lecture by invited experts from the local industry related to the subject. Discussion normally focuses on issues the mobile phone operators phase such as increasing demand of capacity, oprtimised cellular planning, spectrum licensing / auctions, QoS and other related issues. Discussion will also focus on business, commercial and financial aspects and on any recent/future developments related to the subject.		

	A number of assignments will be allocated: survey based, simulation based using software tools such as MATLAB.
Teaching Methodology	Face–to–face
Bibliography	1. T. S. Rappaport, “Wireless Communications: Principles & Practice,” Latest Edition, Prentice-Hall:Upper Saddle River, NJ, ISBN 0-13-042232-0. 2. Jon Mark, Weihua Zhuang, "Wireless Communications and Networking," Latest Edition, Prentice Hall. ISBN: 0130409057. 3. Harri Holma and Antti Toskala (ed.), “WCDMA for UMTS : radio access for third generation mobile communications," Latest Edition, Chichester ; New York : Wiley. 4. John G. Proakis, “Digital communications,” Latest Edition,, Boston : McGraw-Hill. 5. J. D. Parsons, "The Mobile Radio Propagation Channel," Latest Edition, Wiley. 6. ITU Models / Recommendations www.itu.int/pub/R-REC - F (FIXED SERVICES), M (MOBILE), P (RADIOWAVE PROPAGATION), SF (FREQUENCY SHARING), SM (SPECTRUM MANAGEMENT) and www.itu.int/pub/T-REC K , O
Assessment	Examinations 40% Assignment(s) 60% 100%
Language	English

Course Title	Master Thesis				
Course Code	ECE690				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	2nd Year / 3rd Semester				
Teacher's Name	Any Faculty Member				
ECTS	22	Lectures / week	3h x 8 Weeks (For Part A: Research Methods)	Laboratories / week	None
Course Purpose and Objectives	• The student acquires the necessary skills to enable the successful completion of a project. Established research methods for independent research are introduced using methodical processes. This is related to general objectives 5 and 6. • Develop an ability to organize and carry out an extended, independent and novel scientific research work at postgraduate level, employing concepts and methods learned in the program • Synthesize concepts and methods learned in more than one course, and exhibit awareness of previous work in the area of study. • Give a deeper knowledge of the subject at hand and to give an insight into the working processes used within a company, other institutions or within a department. • Extend the knowledge and skills developed in the taught components of the courses of the program • Prepare the student for future independent work as a Master of Science.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Demonstrate written and oral technical research skills. • Select and justify a research topic. • Use various resources to carry out a literature search.				

	• Structure and format the project to agreed conventions. • Design, execute, interpret and report results from empirical research projects. • Manage a project and explain the relevant techniques and tools needed in order to complete it successfully on time and within budgeted resources. • Identify real-world problems to which academic concepts and methods can be realistically applied to improve or resolve the problem situation. • Select and use effectively the methods and techniques appropriate for particular cases. • Plan and manage their work. • Evaluate a proposed solution and prove its worth to the client. • Critically evaluate the project and the proposed solution. • Recognise and describe legal, social or ethical obligations.		
Prerequisites	Consent of Instructor	Co-requisites	None
Course Content	Part A: Research Methods: The nature of research: Definitions and types of research; research process; topic selection and scope; feasibility and value. The literature search: Sources of information; differentiating between types of sources; primary, secondary and tertiary sources; using the library and digital databases to conduct efficient literature reviews; searching the Internet; role of the supervisor. Project management: Methods, techniques and tools for research design, and data collection. Analysis and synthesis: Statistical and qualitative techniques for data analysis; use of appropriate software. Reliability and validity of research projects. Presentation of research findings: Project structure; conventions on citation and quotations; style of writing a report. Part B: Thesis: Students will submit an initial proposal for a project. The project co-coordinator will then allocate an academic supervisor who will liaise		

	with the student to review the initial proposal and to ensure that that the scope of the project is consistent with that of a Masters degree. This will then be followed by an initial report of about 10 pages, which will further expand on: • What the project is intend to achieve. • Why the project is important from an academic and industrial perspective. • How the project will be achieved including proposed methods and techniques. • How the project will be managed. The specific deliverables for each individual's project must be discussed and decided upon in consultation with the academic and industrial supervisors. The roles and responsibilities are outlined below: **Student:** • To identify and scope a suitable problem • Explain the value of the research • To plan and control the project • To carry out the necessary work • To review and evaluate the work done • To prepare and present the project deliverables • To initiate and maintain contact with the academic supervisor **Academic Supervisor:** • To comment on the suitability of the selected project • To discuss the mapping of the project onto the course requirements • To discuss and approve the intended deliverables • To suggest starting points for consideration of background research • To discuss the nature of the thesis and comment on early drafts • To provide advice on issues associated with the project such as design, implementation, and proof of concept as appropriate. To attend any presentation or demonstration of the project.

Teaching Methodology	Face-to-face
Bibliography	Specified by the instructor Howard, K. & Sharp, J.A., THE MANAGEMENT OF A STUDENT RESEARCH PROJECT, Gower Turk, C. & Kirkman, J., EFFECTIVE WRITING: IMPROVING SCIENTIFIC, TECHNICAL AND BUSINESS COMMUNICATION, Chapman & Hall J. Zobel., WRITING FOR COMPUTER SCIENCE, Springer. W. Navidi, Statistics for Engineers and Scientists, McGraw-Hill Science/Engineering/Math; Latest Edition. Statistical Methods for Engineers, by Geoffrey Vining and Scott M. Kowalski, Thomson, Brooks/Cole, Latest Edition. J.G. Paradis, M., Zimmerman,THE MIT GUIDE TO SCIENCE AND ENGINEERING COMMUNICATION, The MIT Press. D. Madsen, SUCCESSFUL DISSERTATIONS AND THESES., A GUIDE TO GRADUATE STUDENT RESEARCH FROM PROPOSAL TO COMPLETION, Jossey Bass. T. Cornford, S. Smithson, PROJECT RESEARCH IN INFORMATION SYSTEMS., A STUDENT'S GUIDE, Macmillian
Assessment	**ASSESSMENT STRATEGY:** The specific deliverables for each individual's project must be discussed and decided upon in consultation with the academic and industrial supervisors. However, each project must involve deliverables falling into the following general categories: (a) A proposed solution to a real-world problem. (b) A proof of concept, which demonstrates the

validity of the proposed solution.

(c) Clear indication of knowledge of relevant work by others in the field.

(d) The selection and application of appropriate theoretical concepts and methods.

(e) A project thesis of between 12,000 to 16,000 words.

Projects will be marked in two ways.

Firstly, according to the following scheme:

- Project justification including its relationship to the current state of the art

  10% 20 marks
- Ability to select and use appropriate methods and techniques

  10% 20 marks
- The clarity, coherence and succinctness with which the solution is developed

  30% 60 marks
- Novelty. Does the work improve significantly the current state of the art?

  30% 60 marks
- Ability to critically review the project and assess its implications for future work in view of the project recommendations and conclusions

  10% 20 marks
- Project Management: Ability to plan and control the project

  10% 20 marks

  ____ _____

  100% 200 marks

	In addition students are reminded about presentation issues: Is the document format (including spelling) of good quality? Is it well organized into appropriate sections? Is the style of language used appropriate for an academic report? **ASSESSMENT:** Project: 100%
Language	English

Course Title	Special Topics in Telecommunication Engineering				
Course Code	ECE624				
Course Type	Elective				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 2nd or 3rd Semester				
Teacher's Name	Any Faculty Member				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	The objective of this course is to give the students a mechanism for learning the latest trends and developments in Telecommunications related to their degree. The content of the course in not fixed and it depends on the research taking place internationally and the research interests of the faculty.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Define, explain and employ material related to subjects in the field of Telecommunications Engineering that are not included in the regular curriculum but rather stem from faculty research on a relative field or from the local telecommunication industry. • Recognize and classify trends in the field of Telecommunications Engineering. • Identify and explain developments in the field of Telecommunications Engineering				
Prerequisites	None	Co-requisites	None		
Course Content	The syllabus for this course will be different every time the course is offered. It is the responsibility of the department to prepare the syllabus at least three months before the beginning of each semester.				
Teaching Methodology	Face–to–face				
Bibliography	N/A				
Assessment	Examinations 70% Project / Assignment(s) 30% 100%				
Language	English				

Course Title	Satellite Systems Engineering				
Course Code	ECE625				
Course Type	Elective				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 2nd or 3rd Semester				
Teacher's Name	TBA				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	The systems approach to satellite design is discussed in this course. The design drivers and requirements, along with the objectives of the mission are integrated in this course.				
Learning Outcomes	Upon succesful completion of this course, students should be able to: • Define satellite systems. • Classify and describe the spacecraft's subsystems. • Describe the spacecraft dynamics • Apply celestial mechanisms into solving problems. • Examine various system and control mechanisms				
Prerequisites	None	Co-requisites	None		
Course Content	Introduction: Spacecraft systems with an emphasis on the platform aspect. The Space Environment: Description of the spacecraft's mission environment. Spacecraft dynamics: An introduction to the dynamics of bodies. Translation, Rotation, Trajectory dynamics, Attitude dynamics. Celestial mechanics: Discussion about the dynamical aspects of the orbital motion of the spacecraft. Two-body problem – particle dynamics Mission Analysis: Ground station visibility, GEO earth orbits, orbit acquisition, station keeping maneuvers Propulsion Systems: Discussion about the basic satellite propulsion systems. Monopropellant propulsion system, Bi-propellant propulsion system, Electric propulsion, apogee engine.				

	Attitude control: Discussion about the attitude dynamics of the spacecraft. Attitude response, Attitude measurement, Attitude control. Electrical power Systems: Discussion about the Power system elements, Primary power systems, Secondary power systems, Power budget. Thermal System: Cover the basics of thermal control in space. Passive systems and active systems. Telemetry Command and Data processing systems: Data formatting, Tele-commanding, Ground stations. Lecture by invited experts from the local space industry related to Satellite Systems. Discussion will focus on technical, business, commercial and financial aspects and on any recent/future developments related to the subject. A number of assignments will be allocated: survey based, simulation based using software tools such as MATLAB.
Teaching Methodology	Face–to–face
Bibliography	P. Fortescue, J.Stark, G.Swinerd Spacecraft systems Engineering, Latest Edition, Wiley-Blackwell. [ISBN-13: 978-0470750124] CNES, Spacecraft Techniques and Technology, Latest Edition, Editions Cépaduès. [ISBN-13: 978-2854286854]
Assessment	Examinations 40% Assignment(s) 60% 100%
Language	English

Course Title	Information Theory and Coding				
Course Code	ECE626				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 1st Semester				
Teacher's Name	TBA				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course is related to information theory and coding which is widely applied in modern wireless systems. It covers a wide range of information theory and coding such as classical information theory entropy, mutual information, channel coding theorem and channel capacity, channel coding techniques such as block coding, convolutional coding, advanced MIMO theory, MIMO capacity, OFDM technique, MIMO-OFDM system & applications. The course aims at familiarising the students with the advanced knowledge of information theory and coding used in the modern wireless systems and applications, and to enable them to work in the telecommunication sector on relevant projects.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Describe the notion of information in the quantitative sense and how the quantity of information could be measured • Explain the concept and properties of entropy and mutual information as it applied to information • Define channel capacities and properties using Shannon's Theorems • Construct efficient codes for data on imperfect communication channels and describe possible implications • Evaluate performance of various coding techniques over fading channels • Recognize advances of coding theory in next generation broadband communication systems				
Prerequisites	ECE612	Co-requisites	None		
Course Content	Foundations: probability, randomness, redundancy, compressibility, noise, bandwidth, and uncertainty related to information. Ensembles, random variables, marginal and conditional probabilities. Metrics of information and the rules of probability. Entropies, measures of information: Marginal entropy, joint entropy, conditional entropy and Chain Rule for entropy. Mutual information				

	between ensembles of random variables. Entropy rates – Markov Chains. Asymptotic Equipartition Property: AEP theorem, AEP consequences on data compression and high probability sets. Data Compression: examples of codes, Kraft inequality, Optimal codes, bounds on the optimal code length, Huffman codes, optimality of Huffman Codes, Shannon-Fano-Elias coding, competitive optimality of the Shannon code. Channel Capacity: Noiseless binary channel, noisy channel with non-overlapping outputs, the binary symmetric channel, binary erasure channel. Symmetric Channels, properties of channel capacity, zero-error codes, hamming codes, source-channel separation theorem. Extensions of the discrete entropies and measures to the continuous case. Signal-to-noise ratio; power spectral density. Gaussian channels. Relative significance of bandwidth and noise limitations. The Shannon rate limit and efficiency for noisy continuous channels. Fourier series, convergence, orthogonal representation. Generalised signal expansions in vector spaces. Independence. Representation of continuous or discrete data by complex exponentials. The Fourier basis. Fourier series for periodic functions. Transform pairs. Sampling; aliasing. The Fourier transform for non-periodic functions. Properties of the transform, and examples. Nyquist's Sampling Theorem derived, and the cause (and removal) of aliasing. Discrete Fourier transform. Fast Fourier Transform Algorithms. Efficient algorithms for computing Fourier transforms of discrete data. Computational complexity. Filters, correlation, modulation, demodulation, coherence. Channel Coding: Fundamentals of Linear Codes: Introduction to Error Detection and Correction; Types of Codes; Minimum Distance. Block Coding Principles: Generator Matrix Description, Systematic Codes, Detection and Correction Bounds. Convolutional Codes (Encoding): encoders; generator polynomials; constraint length; state diagrams; tree and trellis diagrams; distance measures. Convolutional Codes (Decoding): Viterbi algorithm; Soft-Decision Decoding; MAP Decoding. LDPC Codes: Code Density, Tanner Graphs, Belief Propagation. Space-Time Coding and distributed coding. Applications: MIMO, OFDM, MIMI-OFDM & Space Frequency Coding Lecture by invited experts from the local industry on the area of information theory and coding. Discussion normally focuses on current trends on information theory, coding and wireless communications design / implementation challenges, commercial and

	financial aspects and on recent/future developments. A number of assignments will be allocated both survey based and simulation based using software tools such as MATLAB.
Teaching Methodology	Face–to–face
Bibliography	T. M. Cover and J. A. Thomas, Elements of Information Theory, Latest Edition, John Wiley & Sons J. G. Proakis, Digital Communications, Latest Edition., McGraw-Hill R. J. McEliece, The Theory of Information and Coding, Latest Edition, Cambridge University Press E. G. Larsson and P. Stoica, Space-time Block Coding for Wireless Communications, Cambridge University Press A. Abramson, Information Theory and Coding, Latest Edition, McGraw-Hill
Assessment	Examinations 40% Project/Assignments 60% 100%
Language	English

Course Title	Digital Receivers				
Course Code	ECE627				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 1st Semester				
Teacher's Name	TBA				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	The objective of this course is to introduce the overall structure of a digital receiver, as well as typical techniques of synchronisation used by these receivers (phase and delay). It also aims at providing a hands-on experience for designing and implementing such a receiver using software and hardware simulation tools.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Recognise the need of synchornisation of a digital receiver • Describe the typical architecture of a digital receiver • Recognise and evaluate fading channel transmission models and synchronization parameters • Design a technique of synchronisation • Recognise and evaluate the techniques of synchronization • Design, implement GNU radio / USRP applications to perform particular case studies.				
Prerequisites	None	Co-requisites	None		
Course Content	Synchronization Functions, Maximum likelihood estimation, performance limits in synchronization. Detection and parameter synchronization on fading channels: fading channel transmission models and synchronization parameters. Optimal joint detection. Carrier Frequency Recovery with Linear Modulations: Data-aided frequency estimation, decision directed recovery with DPSK, open and closed loop recovery with no timing information, Carrier Frequency Recovery with CPM modulations: Data Aided				

	frequency estimation, ML—based NDA frequency estimation, delay and multiply schemes, clock-aided recovery. Carrier phase recovery with linear modulations: clock aided and data aided recovery, decision directed phase recovery with non-offset modulation. Characterization, modeling and simulation of linear fading channels, digital transmission over continuous-time and discrete-equivalent fading channels. Characterization, Modeling and simulation of discrete equivalent fading channels DSP System Implementation: DSP hardware / software co-design, quantization and number representation, Digital phased locked loop, Bit Error Performance of the DVB chip, Implementation, CAD Tools and Design methodology. Receiver structures for fading channels: outer and inner receiver for fading channels, inner receiver for flat fading channels. Inner receiver for selective fading channels. Recursive computation of the decision metric, maximum-likelihood sequence detection, reduced complexity ML sequence detection. Parameter synchronization for flat fading channels: non-data-aided (NDA) flat fading channel estimation and detection. Data-aided (DA) flat fading channel estimation and detection. DA flat fading channel estimation, uniform DA channel sampling and estimation, aliasing and end effects in DA channel estimation. Parameter synchronization for selective fading channels: non-data-aided (NDA) selective fading channel estimation and detection (LMS-Kalman / LMS- Wiener), decision-directed (DD) selective fading channel estimation and detection. Data-aided (DA) selective fading channel estimation. Maximum-likelihood DA snapshot acquisition. ASIC Design Case Study: Implementation loss, design methodology, digital video broadcast specification, receiver structure, input quantization, timing and phase synchronizer structure. Other topics: OFDM modulation including channel estimation, synchronization and equalization. MIMO communication systems including spatial multiplexing. MIMO in 802.11n standard. GNU Radio and USRP: To transmit / receive signals in wired and wireless channels for a wide range of frequencies. Particular case studies will be prepared by the instructor. Lecture by invited experts from the local industry. Discussion normally focuses on current digital receiver design / implementation / manufacturing challenges and applications, commercial and financial

	aspects and on recent/future developments. A number of assignments will be allocated both survey based and simulation based using software / hardware tools such as MATLAB / GNU Radio / USPR2.
Teaching Methodology	Face–to–face
Bibliography	H. Meys, M. Moeneclaey and S.A. Fetchel, Digital Communication Receivers, Synchronization, Channel Estimation and Signal Processing, Wiley-Interscience, Latest Edition U. Mengali and A. N. D' Andrea, Synchronization Techniques for Digital Receivers (Applications of Communications Theory), Springer, Latest Edition
Assessment	Examinations 40% Project/Assignments 60% 100%
Language	English

Course Title	Advanced Signal Processing				
Course Code	ECE628				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 1st Semester				
Teacher's Name	TBA				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	Introduce advanced analytical tools for solving the statistical and adaptive signal processing problems encountered in communications; and to introduce students to statistical and adaptive techniques for the detection, filtering and matching of signals in noise. Students will also experience the designing of DSP systems and creating commercially-viable applications using high-performance and energy-efficient off-the-shelf processors				
Learning Outcomes	Upon successful completion of this course students should be able to: • Describe various models for real world signals • Analyse the performance of a range of estimation methods • Simulate a wide range of signal processing algorithms and interpret the results • Design specific algorithms for processing real world signals such as audio. • Implement and demonstrate concepts such as sampling, reconstruction and aliasing as well as design of filtering algorithms such as FIR, IIR, FFT using off-the-shelf equipment.				
Prerequisites	None	Co-requisites	None		
Course Content	Introduction: Sampling processes, bandpass sampling, Discrete Fourier Transform for sampled signals, Fast Fourier Transform, and Spectral Estimation, convolution and correlation, random signals, linear timer-invariant systems and transforms. In class examples / exercises using the ARM-based DSP processing education kit. Sampling and finite precision effects: AD/DA. Aliasing, quantisation and oversampling. Sampling, reconstruction and aliasing principles through in-class examples / exercises using the ARM-based DSP processing education kit. Detection and Estimation: Detection theory, analysing the performance of communication systems, detection of signals in noise, the likelihood ratio, optimum detection, bit error, matched filter. Estimate the parameters of a signal, the frequency or phase of a				

	sinusoid, linear unbiased estimators, Wiener and Kalman filtering, maximum likelihood estimation and the Cramer-Rao Lower Bound. Filter Design and filter structures, FIR and IRR filter design and implementation. In class examples / exercises using Arm-based microcontrollers as low-power DSP computing platforms. Baseband Data Transmission: Binary data formats (NZ,NRZ), intersymbol interference and its associated mitigation techniques, binary and duobinary signaling and realization of the matched filter. Digital Modulation Techniques: Digital Modulation / Demodulation, basic techniques of shift keying (frequency, phase, amplitude) and its variants, M-ary systems. Coherent and non-coherent detection and error correction coding. Channel Equalisation and Adaptive Filtering: principles of adaptive filtering, adaptive algorithms (LMS, RLS, etc). design techniques, applications of channel equalization and adaptive filtering. Practical in-class examples / exercises using MATLAB and or ARM-based microcontrollers as low power DSP computing platform. Lecture by invited experts from the local industry. Discussion normally focuses on current DSP design / implementation challenges, commercial and financial aspects and on recent/future developments. A number of assignments will be allocated both survey based and simulation based using software tools such as MATLAB.
Teaching Methodology	Face–to–face
Bibliography	A. V. Oppenheim Discrete-Time Signal Processing, Latest Edition, Prentice-Hall Signal Processing Series M. Vetterli, J. Kovacevic, V. K. Goyal, Foundations of Signal Processing, Latest Edition, Cambridge University Press J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, Latest Edition, Prentice Hall D. S. Reay, Digital Signal Processing Using the ARM Cortex M4, Latest Edition, Wiley J. Yiu, The Definitive Guide to ARM® Cortex®-M3 and Cortex®-M4 Processors, Latest Edition, Newnes S. Steven, Digital Signal Processing: A Practical Guide for Engineers and Scientists (IDC Technology), Latest Edition, Newnes

Assessment	Examinations Project/Assignments	40% 60% 100%
Language	English	

Course Title	Optical Communications				
Course Code	ECE629				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 1st Semester				
Teacher's Name	TBA				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course aims at familiarising the students with the theoretical background required for Optical Communications starting with basic light propagation theory, optical transmitters and receivers, optical signal processing and modulation / demodulation formats. Students are also expected to use the knowledge acquired to carry out their simulation-based assignments.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Describe the operation principles and technology of optical fibre networks. • List and describe the factors that limit light transmission and the information it carries over optical fibres. • Explain the methods commonly used to mitigate these factors. • Design optical transmitter / receiver and identify possible sources of loss. • Describe laser modulation. • List and describe possible applications				
Prerequisites	None	Co-requisites	None		
Course Content	Ray picture of light propagation in optical fibres: Fresnel's Equations / Total Internal Reflection. Guided mode solutions of cylinder from Maxwell's equation: optical fibre modes. Light propagation in optical fibres: dispersion, attenuation. Non-linear optical effects. Fibre design and fabrication. Optical Transmitters, Semiconductor laser physics, single-mode semiconductor lasers, laser characteristics, optical signal generation. Light emitting diodes, transmitter design, Fibre Amplifiers (Erbium doped and Raman). Compensation of fibre losses, optical and electrical signal to noise ratio.				

	Optical Receivers, photodetectors, receiver design, receiver noise, coherent detection, receiver sensitivity and degretation. Optical signal processing, nonlinear oprtical loop mirrors, parametric amplifiers, semiconductor lasers and SOAs. Coupled semiconductor Lasers and SOAs. Wavelength converters, XPM, FWM wavelength converters. Optical switching and regenerators. WDM lightwave systems, components, performance issues, time division multiplexing, sub-carrier multiplexing, code-division multiplexing. Laser modulation (direct and indirect), Laser ringing & chirp, Electro-Absorption (Franz-Keldysh, Quantum Confined Stark Effects, Electro-Refraction and Mach-Zehnder Interferometers Advanced modulation and demodulation formats, shot noise and BER. Sensitivity degretation mechanisms, impact of nonlinear effects. DBPSK, DQPSK, QAM and Orthogonal FDM. Data encoding strategies to maximize data capacity over optical links. Lecture by invited experts from the local industry related to optical communications. Discussion normally focuses on current optical communications network infrastructure design / implementation challenges, commercial and financial aspects and on recent/future developments. A number of assignments will be allocated, both survey based and simulation based using software tools such as MATLAB / NS2 / OPNET / OptSim.
Teaching Methodology	Face–to–face
Bibliography	G. P. Agrawal, Fiber-Optic Communication Systems, Latest Edition, Wiley R. Ramaswami, K. N. Sivarajan, G. Sasaki, Optical Networks, A practical perspective, Latest Edition, Morgan Kaufmann Publishers E. Hecht, Optics, 4th Edition, Latest Edition, Addison-Wesley D. K. Mynbaev and L. L. Scheiner, Fiber-Optic Communications Technology, Latest Edition, Prentice-Hall A. Yavir, Optical Electronics in Modern Communications, Latest Edition, Oxford University Press

Assessment	Examinations Project/Assignments	40% 60% 100%
Language	English	

Course Title	Satellite Communications				
Course Code	ECE630				
Course Type	Compulsory				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 1st Semester				
Teacher's Name	Constantinos Kassianides				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course focuses on Satellite communication systems. Starting with the link budget and planning issues of satellite systems. Furthermore, it discusses modulation and coding as well as multiple access schemes for satellite communication systems. Digital audio and video broadcasting services are examined. In addition, satellite mobile personal communication systems are described and various business satellite system cases are evaluated through planning of satellite links for achieving the highest possible quality of service.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Describe principles of satellite communications • Design systems and simulate satellite communication links • Discuss satellite communication systems operation and planning • Recognise and evaluate modern satellite multiple access, modulation and coding schemes. • Identify and/or describe the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications.				
Prerequisites	None	Co-requisites	None		
Course Content	Introduction to Satellite Systems Radio Regulations, ITU-R/T, IFRB, Frequencies, interference management, space and ground segment components, earth-stations, bus and payloads, antennas and coverage, transparent and non-transparent transponders. FSS, MSS, BSS applications areas. GEO, HEO, MEO, LEO, echo control and effect on services (data, speech, etc). SCPC, MCPC, multiple access schemes. Traffic routing and single and multi-beam satellites. Satellite Systems Planning Antenna theory (focusing on Satellite Systems), gain, radiation				

	patterns. Noise sources, noise temperature, noise figure, sky noise, calculation of G/T and C.N ratio for up-path and down-path. Intermodulation, back-off, interference and C/I calculation. Effects of rain for FSS and multipath shadowing for MSS systems. Calculation of margins, link budget with overall C/N and specify availability. Define QoS. GEO and non GEO link budgets. Digital modulation, modems, filtering and bandwidth calculation. FEC coding, code rates and code types. System QoS requirements. Regulation of Spectrum Frequency assignments and limitations. ITU recommendations in fixed mobile and broadcast areas. Coordination procedures for GEO and for non-GEO systems, management of interference. Modulation and Coding MPSK for Satellite Communications, MSK, QAM, etc. Effects of non-linearities, interference, etc. Types of FEC coding, block, convolutional. Code parameters, rate, constraint length, algorithms (Viterbi, Reed-Solomon, Turbo), choice of code types for applications, interleaving. Speech and Video Coding PCM, ADPCM, CELP. Delay quality parameters, echo cancellation., MPEG4 scheme and methods of transmission. Error protection and packetisation. Digital Broadcasting: Infrastructure of broadcasting, HDTV standards, Digital TV, source encoding and MPEG. DVB channel coding and modulation. Link budgets and the use of coding conditional access and commercial application VOD. Satellites for DAB and receivers. Multiple Access Review of FDMA and TDMA. TFMA frame details, synchronization, open and closed loops, efficiency and frame design. SS-TDMA frame design and synchronization aspects. CDMA spreading codes, synchronization and power control. Receiver tracking and acquisition. Capacity calculations – importance of interference (link budget examples). Random access, ALOHA,S-ALOHA, RA-TDMA. Satellite Systems – Business Scenarios and Markets A review of current and future R&D related topics for Satellite Communications. Multimedia, mobile, broadband etc. Business scenarios. VSAT systems, composition of network. Delay throughput analysis. Lecture by invited experts from the satellite operator local industry. Discussion normally focuses on current satellite communication network infrastructure design / implementation challenges, commercial and financial aspects and on recent/future developments.

	A number of assignments will be allocated both survey based and simulation based using software tools such as MATLAB / EXCEL. Assignments will mainly focus on the calculation of link budget planning for highest possible QoS / availability (based on the requirements).
Teaching Methodology	Face–to–face
Bibliography	G. Maral, and M. Bousquet, Satellite Communication Systems, Latest Edition, J Wiley G. Maral,. VSAT Networks, Latest Edition, J. Wiley M. Richharia, Satellite Communication Systems Design Principles Macmillan, Latest Edition B. G. Evans, Satellite Communication Systems, IET, Latest Edition
Assessment	Examinations 40% Project/Assignments 60% 100%
Language	English

Course Title	Distributed Computing and Parallel Processing				
Course Code	ECE631				
Course Type	Elective				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 2nd or 3rd Semester				
Teacher's Name	Vicky Papadopoulou – Lesta				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course provides graduate students with experience of parallel and distributed computing. It gives an overview of parallel and distributed computers, and parallel computation. The goal of the course is to introduce the main algorithmic techniques in the framework of parallel and distributed models of computing; to define the most significant complexity parameters and the computational limits of parallelism and concurrency. Finally computational tools to design and analyze parallel and distributed algorithms are given.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Describe and discuss on fundamentals of parallel and distributed computing including parallel/distributed architectures and paradigms. • Describe currency and the issues that arise in concurrent computation as opposed to serial computation. • Discuss the requirements and special concerns of real-time environments. • Describe, discuss and compare on fault tolerant systems, distributed algorithms, and multiprocessing. • Evaluate the impact and performance of architecture topology on the formulation of parallel/distributed algorithms. • Utilize basic techniques in system performance evaluation				
Prerequisites	None		Co-requisites	None	

Course Content	• Interconnection networks
	  o Rings, meshes, meshes of trees, hypercubes, butterflies, trees, fat trees, Clos, Benes, de Bruijn, shuffle-exchange, Omega, flip, etc.
	  o Diameter, bisection, average distance, symmetry
	• Parallel architectures
	• Arithmetic algorithms
	  o Addition, multiplication, division
	  o Straightline codes and parallelization
	• Combinatorial algorithms
	  o Maximum spanning tree
	  o Maximum matching
	• Numerical algorithms
	• Systolic array algorithms
	• Fundamental algorithms: prefix, sorting, and FFT
	• Routing
	  o Randomized vs deterministic algorithms
	  o Packet routing
	  o Wormhole routing
	  o Buffer analysis
	• Embedding and simulation
	• Parallel primitives: scans, broadcast, total exchange
	• Fault tolerance
	• Optical networks

	◦ Technology ◦ Routing ◦ Lower bounds • Reconfigurable architectures ◦ Rationale ◦ Networks and reconfiguration algorithms ◦ Embedding • Simulation of ideal parallel models • Distributed algorithms ◦ Symmetry breaking ◦ Leader election ◦ Byzantine Generals Problem (consensus problems) ◦ Approximate consensus ◦ Snapshots ◦ Broadcasting ◦ Clock synchronization
Teaching Methodology	Face–to–face
Bibliography	F. T. Leighton., Introduction to Parallel Algorithms and Architectures: Arrays, Trees, Hypercubes. Morgan Kaufmann, 1992. N. Lynch.,Distributed Algorithms. Morgan Kaufmann, 1996. Nicola Santoro: Design and Analysis of Distributed Algorithms, Whiley ed., 2007 Attiya, Hagit, and Jennifer Welch. Distributed Computing., Fundamentals, Simulations, and Advanced Topics. 2nd ed. New York, NY: Wiley-Interscience, 2004. ISBN:9780471453246.

	Herlihy, Maurice, and Nir Shavit. *The Art of Multiprocessor Programming*. Burlington, MA: Morgan Kaufmann, 2008. ISBN: 9780123705914.
Assessment	Examinations 50% Project / Assignment(s) 50% 100%
Language	English

Course Title	Approximation & Randomized Algorithms				
Course Code	ECE632				
Course Type	Elective				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 2nd or 3rd Semester				
Teacher's Name	Georgios Stylianou				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This is an advanced course in the design and analysis of algorithms. It treats two main topics: 1. *Randomization*: the power of randomization, the design of randomized algorithms, the analysis of randomized algorithms using `basic' probability. 2. *Approximation*: the effective solution of NP-hard optimization problems to approximate the correct answer within a specified accuracy, the design and analysis of such algorithms. Concerning, approximation algorithms, we will study concrete problems from graph theory to scheduling (for example, Set Cover, Steiner trees, Facility Location, ...) and design, analyze algorithms using techniques of greedy algorithms, local search or technique based on linear programming. Concerning randomized algorithms the course aims to teach rigorous methods to design and analyze such algorithms, and to present some of the key applications of randomization in diverse fields of computer science such as distributed computing, resource allocation, scheduling, and packet routing.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Find probably good approximation algorithms for the problems that are hard to solve exactly; and prove that finding better approximations are hard. • Explain techniques for designing approximation algorithms; many of these involve fairly mathematical proofs. • Utilize standard techniques for dealing with intractable problems, such as approximation and randomization, and have a basic understanding of when such techniques can				

<table>
<tr><td></td><td colspan="3">be expected to be helpful.
• Apply the fundamentals of discrete probability theory;
• Describe the basic randomized algorithms that have been discussed in class; be able to analyze selected randomized algorithms;
• Describe the theory of Markov chains and their algorithmic applications;
• Describe and utilize selected randomized data structures;
• Utilize the probabilistic method.</td></tr>
<tr><td>Prerequisites</td><td>None</td><td>Co-requisites</td><td>None</td></tr>
<tr><td>Course Content</td><td colspan="3">APPROXIMATION ALGORITHMS:
Combinatorial Techniques:
Lower Bounding Techniques and Metric TSP,
Euclidean TSP: Karp's Partitioning Scheme
Karp's Partitioning Scheme: Probabilistic Analysis
FPTAS for Knapsack
Greedy Algorithms for Makespan
PTAS for Makespan
Local Search: The Min Degree Spanning Tree Problem

Linear Programming Relaxations:
Linear Programming: Vertex Cover
Randomized Rounding applied to VLSI Layout
Filtering: Facility Location
Dual Fitting and the Greedy Set Cover Algorithm
Primal Dual Method and Vertex Cover
Primal Dual applied to the Steiner Forest Problem
Maximum Cut Approximation via Local Search

RANDOMIZED ALGORITHMS:
Randomized algorithms and methods.
Examples of randomized algorithms.
Methods of game theory.
Main types of randomized algorithms.
Randomized complexity classes.
Chernoff's bounds.
Moments and deviations.
Probabilistic methods.
Markov chains and random walks.
Algebraic methods.
Aplications:
o Linear programming.
o Parallel and distributed algoritms.</td></tr>
</table>

	o Randomization in cryptography. o Randomized methods in theory of numbers. Geometric Algorithms Graph Algorithms Number-theoretic Algorithms **SPECIAL TOPICS:** Algorithmic Game Theory
Teaching Methodology	Face–to–face
Bibliography	Approximation Algorithms., Vijay Vazirani, Springer-Verlag, 2004. Randomized Algorithms., Rajeev Motwani, Prabhakar Raghavan, Cambridge Approximation Algorithms for NP-hard Problems., Dorit S. Hochbaum, PWS Publishing Company, 1995, University Press, 1995. Algorithmic Game Theory.,Noam Nisan, Tim Roughgarden, Eva Tardos, Vijay V. Vazirani, Cambridge University Press, 2007.
Assessment	Examinations 50% Project / Assignment(s) 50% 100%
Language	English

Course Title	Graph Theory & Applications in Networks				
Course Code	ECE633				
Course Type	Elective				
Level	Master (2nd cycle)				
Year / Semester	1st Year / 2nd or 3rd Semester				
Teacher's Name	Ioannis Michos				
ECTS	8	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	The course objective will be a foray into several topics in the theory of graphs. The first half of the course will be a survey of some major branches of this broad field. The second half will examine specific topics in greater depth. I intend to address both theoretical and algorithmic aspects.				
Learning Outcomes	Upon successful completion of this course students should be able to: • Solve various real-world problems by using counting techniques and graph theory; • Develop their ability to read, comprehend, and create mathematical arguments. • Write precise and accurate mathematical definitions of objects in graph theory; • Validate and critically assess a mathematical proof; • Use a combination of theoretical knowledge and independent mathematical thinking in creative investigation of questions in graph theory; • Write about graph theory in a coherent and technically accurate manner.				
Prerequisites	None	Co-requisites	None		
Course Content	Colouring: Perfect graphs, Choosability, Nowhere zero-flows, Non-constructive methods. Cliques, bonds and circuits: Packing & Covering, Decomposing, Extremal substructures (Hamilton cycles, max-cut, clique number).				

	Connectivity, matchings and network flows: Reliability, Optimization, Algorithms and Heuristics. Embeddings and minors: Planar graphs, Surface embeddings, Tree width, Graph structure theory, Simplicial and k-sum decompositions. Random graphs: Evolution, Thresholds, Existence proofs, 0-1 laws, Ramsey theory. Algebraic: Cayley graphs, Eigenvalues, Expanders, Hypercubes, Distance regular graphs. Related objects: Digraphs, Tournaments, Matroids, Hypergraphs, Designs, Posets. Optimization: Weighted matching, matroid intersection, matroid partition, flow algorithms.
Teaching Methodology	Face–to–face
Bibliography	Graph Theory., Reinhard Diestel, Springer-Verlag, 3rd edition, 2000. Introduction to Graph Theory., Douglas B. West, Prentice Hall, 2001, 2nd ed. Graph Theory with Applications., J. A. Bondy and U. S. R. Murty, 1976. Modern Graph Theory., B. Bollobás, Springer, 1998.
Assessment	Examinations 50% Project / Assignment(s) 50% 100%
Language	English

Course Title	Data Communications and Computer Networks				
Course Code	CSC322				
Course Type	Optional				
Level	Foundation				
Year / Semester	Prior to the first year of study / N/A				
Teacher's Name	Andreas Grondoudis				
ECTS	6	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	To provide an overview of the broad and constantly emerging field of data communications and computer networks. Data communication is discussed as the necessary tool for understanding computer communication networks.				
Learning Outcomes	Upon succesful completion of this course students should be able to: • State and identify concepts relating to data communications; communication protocols and layered protocol architectures • State and interpret protocol communication standards like OSI/RM and TCP/IP as used in computer networking and internetworking. • Recognize and explain data transmission fundamentals and types of media (both wired and wireless) • Define and discuss data link control protocols and their functionality • Recall and explain multiplexing techniques and their applications • Define, explain and exemplify concepts related to Local Area Networks (both wired and wireless); their topologies and protocols; their types and transmission technologies • Describe, explain and classify types of security attacks; types and algorithms of encryption; security functionality in IP versions 4 and 6				
Prerequisites	CSC214		Co-requisites	None	

Course Content	Introduction Communication systems, entities and components. Computer networks as communication system; their topologies and types. Communication protocols, layered communications and protocols architectures. The OSI/RM and TCP/IP standards Data communication systems; transmission, impairments and media Data transmission basics; frequency concepts, bandwidth, spectrum; data rate and bandwidth. Analog and digital transmission; wired transmission impairments. Transmission media and impairments for both wired (UTP, STP, Coaxial, Fiber) and wireless (Microwave, Radio, Infrared). Signal encoding techniques; analog-to-digital (and visa-versa) data-to-signal conversion Communication techniques; Data Link Control; Multiplexing Synchronous & asynchronous transmission, Error control: types, detection and correction. Flow control: Stop-and-wait, Sliding-window, Automatic Repeat Request. The High-level Data Link Control protocol: modes, frame types and operation. Frequency Division Multiplexing, Synchronous and Statistical Time Division Multiplexing, multiplexing applications (CATV, ADSL) Local area networks; wired and wireless LAN topologies, protocols and the IEEE 802 standards; LAN interconnection, bridges, hubs, switches. Ethernet versions. Cellular systems: frequency reuse, capacity increase, operation. Wireless LANs: applications/types and transmission technologies Network security Requirements; types of attacks; symmetric and asymmetric encryption techniques and their algorithms; Secure Socket Layer; IPv4 and IPv6 security; wireless protected access
Teaching Methodology	Face–to–face
Bibliography	Stallings, William, DATA AND COMPUTER COMMUNICATIONS, International edition, Prentice Hall A. Tanenbaum, COMPUTER NETWORKS, Pearson Prentice Hall U. Black, DATA COMMUNICATIONS AND DISTRIBUTED SYSTEMS, Pearson Prentice Hall Journal: ACM Communications Journal: IEEE Transactions on Networking Halsall, F., DATA COMMUNICATIONS, COMPUTER NETWORKS AND OSI, Addison-Wesley

	William A. Shay, UNDERSTANDING DATA COMMUNICATIONS AND NETWORKS, Thomson Learning (Course) Michael A. Gallo, William M. Hancock, COMPUTER COMMUNICATIONS AND NETWORKING TECHNOLOGIES, Thomson Learning (Course) Marion Cole, INTRODUCTION TO TELECOMMUNICATIONS: VOICE, DATA AND THE INTERNET, Prentice Hall Wayne Tomasi, INTRODUCTION TO DATA COMMUNICATIONS AND NETWORKING, Prentice Hall Regis J. Bates, Donald W. Gregory, VOICE AND DATA COMMUNICATIONS HANDBOOK, McGraw-Hill William Stallings, BUSINESS DATA COMMUNICATIONS Prentice Hall
Assessment	Examinations 75% Coursework/Assignments 25% 100%
Language	English

Course Title	Wireless and Mobile Networks				
Course Code	CSC404				
Course Type	Optional				
Level	Foundation				
Year / Semester	Prior to the first year of study / N/A				
Teacher's Name	Konstantinos Katzis				
ECTS	5	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	The aim of the course is to examine the structure and architecture of wireless and mobile networks, systems and applications. The mobility of nodes and end-users has behavioral implications on all layers of the OSI protocol stack form the Data Link up to the Application Layer. Handling and adapting to mobility necessitates the introduction changes in the protocol stack. Emerging applications enabled due to mobility will be investigated too.				
Learning Outcomes	Upon succesful completion of this course students should be able to: • Recall, classify and describe wireless technologies. • Analyse cellular wireless network topologies. • Analyse and compute physical property of wireless networks. • Recall and evaluate radio resource management techniques. • Compare and evaluate different wireless communication protocols.				
Prerequisites	CSC322	Co-requisites	None		
Course Content	Introduction Wireless technology, transmission fundamentals, antennas and propagation, signal encoding techniques, coding and error control. Satellite Communications Classification of satellite orbits, GEO orbit, LEO orbit, MEO orbit, link performance factors, capacity allocation strategies Cellular wireless networks Cellular network organization, frequency reuse, hand-off strategies and metrics, power control, traffic engineering, traffic intensity, cellular wireless networks systems and services, GSM, GPRS, SMS, UMTS.				

	Mobile IP Mobile IP uses and operation, registration, authentication, tunneling. Wireless LANs Wireless LANs technologies, WLANs applications, the IEEE 802.11 standards and operation, hand-offs, fast hand-offs. Ad-hoc networks, issues in ad-hoc networks, routing in ad-hoc networks, encryption in ad-hoc networks. Wireless Sensor Networks, architecture and network protocols. BlueTooth techniques BlueTooth Application Areas, BlueTooth Protocol Architecture, usage models, frequency hopping, BlueTooth audio, BlueTooth Link security.
Teaching Methodology	Face–to–face
Bibliography	William Stallings, WIRELESS COMMUNICATIONS AND NETWORKS, Prentice Hall Yi-Bing Lin, Imrich Chlamtac, WIRELESS AND MOBILE NETWORK ARCHITECTURES, John Wiley & Sons; ISBN: 0471394920 Ellen Kayata Wesel, WIRELESS MULTIMEDIA COMMUNICATION NETWORKING VIDEO, VOICE, AND DATA, Addison-Wesley Theodore S. Rappaport, WIRELESS COMMUNICATIONS PRINCIPLES & PRACTICES, Prentice Hall K. Pahlavan and P. Krishnamurthy, PRINCIPLES OF WIRELESS NETWORKS, Prentice Hall C. Siva Ram Murthy, B.S. Manoj: AD HOC WIRELESS NETWORKS : ARCHITECTURES AND PROTOCOLS Pearson Education
Assessment	Examinations 70% Assignments 25% Class Participation 5% 100%
Language	English

Course Title	Algorithms				
Course Code	CSC407				
Course Type	Optional				
Level	Foundation				
Year / Semester	Prior to the first year of study / N/A				
Teacher's Name	Vicky Papadopoulou-Lesta				
ECTS	5	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	This course is about the design and analysis of algorithms for computational problems, and how to think clearly about analyzing correctness and running time. The objective of this course is to provide the intellectual tools needed for designing and analyzing algorithms for new problems the students may face in the future. Specific algorithms for a variety of problems will be studied, such as greedy techniques, divide-and-conquer, randomized algorithms, dynamic programming, and others, as well as general design and analysis techniques.				
Learning Outcomes	On successful completion of the course, the student will be able to: • Explain and use fundamental algorithms and algorithmic techniques. • Explain the use of big-O, Omega, and Theta notation to describe the amount of work done by an algorithm, and apply them to provide tight bounds on algorithmic complexity. • Create correctness proofs and estimate the running time of a given algorithm. • Discuss factors other than computational efficiency that influence the choice of algorithms, such as programming time, maintainability, and the use of application-specific patterns in the input data. • Design new algorithms for specific applications, using the algorithms and algorithmic techniques presented.				
Prerequisites	CSC401	Co-requisites	None		
Course Content	Analysis framework: O, Θ, Ω notations Mathematical analysis: nonrecursive and recursive algorithms. Graphs, trees and their properties. Breadth- and depth-first search in graphs, topological sort, recurrences.				

	Divide-and-conquer: Multiplication of Large Integers and Strassen's Matrix Multiplication, Closest-Pair and Convex-Hull Problems by Divide-and-Conquer Sorting and Selection: Randomization, Median Finding, Quick Sort, Radix Sort, selection, Lower Bound for Sorting Greedy technique: Huffman's Codes, Minimum Spanning Tree algorithms: Kruskal's Algorithm, Prim's Algorithm, single pair Shortest Paths algorithm: Dijkstra's Algorithm Dynamic Programming: Single Source Shortest Path algorithms: Warshall's and Floyd's Algorithms, Knapsack Problem, Optimal Binary Search Trees, The Knapsack Problem and Memory Functions Amortized Analysis: Aggregate Method, Accounting Method, Potential Method, Dynamic Tables Iterative Improvement: The Simplex Method, the Maximum-Flow Problem (Ford-Fulkerson method), Maximum Matching in Bipartite Graphs, the Stable Marriage Problem Limitations of Algorithm Power: Lower-Bound Arguments, Decision Trees, P, NP, and NP-complete Problems, approximation algorithms Coping with the Limitations of Algorithm Power: Backtracking, Branch-and-Bound, Approximation Algorithms for NP-hard Problems (Vertex-cover problem, the traveling salesman problem, the set-cover problem, the vertex-coloring problem).
Teaching Methodology	Class Instruction: 42 hours Consultations/Computer Lab: 30 hours
Bibliography	Anany V. Levitin, INTRODUCTION TO THE DESIGN AND ANALYSIS OF ALGORITHMS Addison Wesley T. H. Cormen, C. E. Leiserson, R. L. Rivest and C. Stein, INTRODUCTION TO ALGORITHMS, MIT Press S. Dasgupta, C. Papadimitriou, U. Vazirani, ALGORITHMS, McGraw-Hill R. Johnsonbaugh, M. Schaefer, ALGORITHMS, Prentice Hall

Assessment	Examinations	75%
	Course Work/Assignments	25%
	Class Participation	5%
		100%
Language	English	

Course Title	Electric and Magnetic Fields				
Course Code	ECE351				
Course Type	Optional				
Level	Foundation				
Year / Semester	Prior to the first year of study / N/A				
Teacher's Name	Katerina Papanikolaou				
ECTS	6	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	The objective of this course is to provide participants an overview of fundamental concepts of electric and magnetic field theory. The basic laws of electromagnetism are thoroughly described and applied to elementary problems involving steady and alternating fields and currents. Students are also presented to the nature and application of electromagnetic fields in engineering.				
Learning Outcomes	Upon succesful completion of this course students should be able to: • State and explain the definitions and physical significance of the important quantities in basic electricity and magnetism (electric charge and force, electric field and flux, electric energy and potential, capacitance, magnetic force, magnetic field and flux, mutual and self-inductance) • Define the basic laws and relationships between these quantities and the behavior of the Electric and Magnetic Fields • State, explain and apply Maxwell's equations to solve problems • Explain the fundamental relationships as embodied in Maxwell's equations • Analyse transmission lines, transformers and stubs • Evaluate wave propagation in different media				
Prerequisites	ECE212	Co-requisites	None		
Course Content	Vector Analysis: Overview of vector analysis. Introduction to cartesian coordinates and vector calculations. Electric charge and force: The Coulomb's Law. Overview of the electric field. Addition of electric forces and fields. Principle of superposition and electric field lines.				

	Electric dipole: Electric flux and Gauss's Law. Using Gauss's Law in application examples. Overview of conductors in electric fields. Electric potential and potential difference: Finding the electric potential. Conservative nature of the Electric field. Capacitance: Capacitance calculation. Dielectrics. Electric current and resistance. Electromotive force. Kirchoff's laws: The RC circuit. The magnetic field and magnetic field lines. Magnetic flux. The Lorentz force Biot-Savart Law: Torque on a current loop. Magnetic dipole. Ampere's Law. Electromagnetic Induction: Faraday's Law. Lenz's Law. Mutual and self inductance. Magnetic Energy: Maxwell's modification of Ampere's Law. Maxwell's equations and electromagnetic waves. Transmission line theory: Time and space dependence of signals. Transmission line parameters, standing wave ratio, input impedance. Impedance matching: Wave propagation, types of transmission lines, Smith chart, Line stub matching, quarter wave transformer and impedance matching. Waveguides: Propagation modes and equations. Cut-off frequency and wavelength.
Teaching Methodology	Face–to–face
Bibliography	F.T Ullaby, E. Michielssen and U. Ravaioli, Fundamentals of Applied Electromagnetics, 2nd Edition, Prentice Hall, 2010. H.D. Young, R.A. Freedman and L. Ford, University Physics, 12th Edition, Addison-Wesley, 2006. W.H. Hayt and J.A. Buck, Engineering Electromagnetics, Mc-Graw Hill, 2012.

	D.M. Pozar, Microwave Engineering, 3rd Edition, Wiley, 2009
Assessment	Examinations 75% Course Work 25% 100%
Language	English

Course Title	Digital Signal Processing				
Course Code	ECE431				
Course Type	Optional				
Level	Foundation				
Year / Semester	Prior to the first year of study / N/A				
Teacher's Name	Konstantinos Katzis				
ECTS	5	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	Digital Signal Processing (DSP) is used in numerous real life applications. The aim of this course is to get the students to learn about digital signals, and about processing techniques. In particular sampling, transformations and digital filter design are studied. By the end of the course students will gain experience in designing and analyzing DSP systems.				
Learning Outcomes	Upon succesful completion of this course students should be able to: • Define the basic algorithms of processing one dimensional digital signals • Define the basic signal transforms and their use in signal processing • Design digital filters for enhancing/depressing different signal characteristics. • Describe real life applications of Digital Signal Processing.				
Prerequisites	ECE212	Co-requisites	None		
Course Content	Introduction: Benefits of digital over analogue signal processing, typical real life applications and uses of DSP, Sampling and Reconstruction of Signals, key DSP operations (convolution, correlation, digital filtering, discrete transformation) Fourier Discrete Transform (DFT): Fourier Series and the Fourier transform, the Discrete Fourier transform (DFT) and its inverse, computational complexity. Comparison with other discrete transforms (Discrete cosine and Walsh transform)				

	The z-transform: The z-transform, the inverse z-transform (power series method, partial fraction expansion method, residue method), properties of the z-transform. Application of the z-transform (frequency response estimation, pole-zero description of signals, stability considerations, impulse response estimation). Correlation and Convolution: Cross and auto-correlation, applications of correlation, implementation of fast correlation. Properties of convolution, circular convolution, fast linear convolution, implementation. Digital Filter Design: Introduction, types of digital filters, filter design (specification, coefficient calculation, realization, analysis and implementation). Finite impulse response (FIR) and infinite impulse response digital filters (IIR) filter design. Further topics in DSP: Multi-rate Digital Signal Processing (Uses of multi-rate DSP, sampling rate increase/decrease, design of sampling rate converters). Spectrum estimation and analysis (Principles of spectrum estimation, parametric and non-parametric spectrum estimation techniques, comparison of estimation methods) Practical applications - case studies: Overview of DSP Integrated circuits, block level design of DSP systems, analysis of key applications of DSP, implementation of DSP systems for particular real life applications.
Teaching Methodology	Face–to–face
Bibliography	E. C. Ifeachor and B. W. Jervis, DIGITAL SIGNAL PROCESSING - A PRACTICAL APPROACH Addison-Wesley R D Strum & D E Kirk, FIRST PRINCIPLES OF DISCRETE SYSTEMS AND DIGITAL SIGNAL PROCESSING, Addison-Wesley K. Steiglitz , A DIGITAL SIGNAL PROCESSING PRIMER Addison-Wesley R. Kuc, INTRODUCTION TO DIGITAL SIGNAL PROCESSING, McGraw-Hill John Proakis and Dimitris Manolakis, DIGITAL SIGNAL PROCESSING, PRINCIPLES, ALGORITHMS AND APPLICATIONS, Prentice Hall

	J. Candy, SIGNAL PROCESSING, McGraw-Hill C.D. McGillem and G. R. Cooper, CONTINUOUS AND DISCRETE, SIGNAL AND SYSTEM ANALYSIS CBS International Editions Richard G. Lyons, UNDERSTAND DIGITAL SIGNAL PROCESSING, Prentice Hall
Assessment	Examination 70% Class Participation/ Assignments 30% 100%
Language	English

Course Title	Microwave and Optical Transmission				
Course Code	ECE452				
Course Type	Optional				
Level	Foundation				
Year / Semester	Prior to the first year of study / N/A				
Teacher's Name	Konstantinos Katzis				
ECTS	6	Lectures / week	3 Hours	Laboratories / week	None
Course Purpose and Objectives	The objective of this course is to present participants the principles and propagation of microwave and optical waves. Students develop skills in electromagnetic wave theory which can be used to explain the behaviour of a wide variety of practical microwave and optical transmission systems (both mathematically and physically).				
Learning Outcomes	Upon succesful completion of this course students should be able to: • Describe the mathematical and physical development of Maxwell's equations • Define the theory and practice of plane radio, microwave and optical waves in free space • Examine boundary conditions and plane waves principles such as reflection and refraction at metal and dielectric interfaces which are used in practical optical and microwave systems • Explain the use of radio waves, microwaves and optical waves in free space and through materials with losses, as well as the concept of microwave heating and safety levels • Analyse the physics and mathematics of guided waves and their applications in optical and microwave systems • Identify electromagnetic principles of optical waveguides				
Prerequisites	ECE212	Co-requisites	None		
Course Content	Microwave and optical systems: Introduction to microwave and optical systems. Waveguide structure. Formation of guided modes. Propagating power. Overview of practical examples and theory.				

	Transmission lines and microwave networks: Transmission lines. Wave propagation on a transmission line. Lumped element model. Terminated transmission lines. VSWR and return loss. The Smith Chart. Basic operations of Smith Chart. Network analysis. The transmission (ABCD) Matrix. Maxwell's equations: Introduction to static fields. Vector equations and mathematics associated with electromagnetic theory. Overview of Maxwell's equations. Displacement current. Wave equations: Radio and optical waves in free space. Plane waves: Travelling waves, impedance of media, polarisation, standing waves and energy relations. Waves in dissipative media and practical examples. Microwave heating and safety levels Reflection and refraction of plane waves: Boundary conditions. Normal and oblique incidence. Total internal reflection. Brewster angle. Applications in optics and lasers. Principles of microwave waveguides: Parallel plate waveguides. Microstrip description. Rectangular waveguides and coaxial lines. Principles of optical waveguides: Planar dielectric waveguides. Optical fibres. Optical fibre transmission systems.
Teaching Methodology	Face–to–face
Bibliography	D.M. Pozar, Microwave Engineering, 3rd Edition, Wiley, 2009. Z.B. Popovic and B.D. Popovic, Introductory Electromagnetics, Prentice Hall, 2000. S. Harsany, Principles of Microwave Technology, Prentice Hall, 2005. K. Okamoto, Fundamentals of Optical Waveguides, Academic Press, 2000
Assessment	Examinations 75% Course Work/Assignments 25% 100%
Language	English