
UNIVERSITATEA "POLITEHNICA"
DIN TIMISOARA
**FACULTATEA DE ELECTRONICA**
**SI TELECOMUNICATII**


# PLAN DE ÎNVĂŢĂMÂNT ŞI PROGRAME ANALITICE

**Pentru domeniul:**
**INGINERIE ELECTRONICĂ ŞI TELECOMUNICAŢII**

Master

Anul universitar 2015 - 2016

## COMMUNICATION NETWORKS

**CURRICULUM**
**Major: Electronics and Telecommunications – Master Studies in English**

| Nr crt | Disciplina | C | S | L | P | Cr/Ex* |
|---|---|---|---|---|---|---|
| **Ist Year, 1st Semester** | | | | | | |
| 1 | Antennas and Wave Propagation | 2 | 0 | 0 | 2 | 8/E |
| 2 | Advanced Topics in Signal Processing | 2 | 0 | 0 | 1 | 7/E |
| 3 | Selected Topics in Communication Engineering | 2 | 0 | 1 | 1 | 8/E |
| 4 | Elective 1 | 2 | 0 | 1 | 0 | 7/D |
| | **Total** | **8** | **0** | **2** | **4** | **30** |
| **Ist Year, 2nd Semester** | | | | | | |
| 1 | Pattern Recognition | 2 | 0 | 1 | 1 | 8/E |
| 2 | Networks Modelling | 2 | 0 | 1 | 0 | 7/E |
| 3 | Video Networks | 2 | 0 | 1 | 1 | 8/E |
| 4 | Elective 2 | 2 | 0 | 1 | 0 | 7/D |
| | **Total** | **8** | **0** | **4** | **2** | **30** |
| **IInd Year, 3rd Semester** | | | | | | |
| 1 | Mobile Communication Networks | 2 | 0 | 2 | 0 | 8/E |
| 2 | Optical Communication Systems and Networks | 2 | 0 | 2 | 0 | 8/E |
| 3 | Elective 3 | 2 | 0 | 1 | 0 | 7/E |
| 4 | Elective 4 | 2 | 0 | 0 | 1 | 7/D |
| | **Total** | **8** | **0** | **5** | **1** | **30** |
| **IInd Year, 4th Semester** | | | | | | |
| 1 | Practical Training/Research | | | | | 15/D |
| 2 | Master Thesis Elaboration | | | | | 15/E |
| | **Total** | | | | | **30** |

| | |
|---|---|
| Elective 1 | Modern Programming Techniques<br>PCBA Design and Manufacturing<br>Mathematical Morphology |
| Elective 2 | Network Planning<br>Computer Networks Administration |
| Elective 3 | Resource Management in Wireless Networks<br>Broadband Communication Networks |
| Elective 4 | Advanced Multimedia Technologies<br>Spectral Analysis and Estimation |

**Legend**

| C | S | L | P | Cr/Ex* |
|---|---|---|---|---|
| Course | Seminar | Laboratory | Project | Credits/Examination form |

* Evaluation form: E = exam; D = distributed evaluation

## *ANTENNAS AND WAVE PROPAGATION*

**A. COURSE OBJECTIVES**

Applications oriented approach to antennas and wave propagation motivarted by recent developments in fields such as wireless communications, information technology, radar and material science.

**B. COURSE TOPICS**

**Maxwell's equations:** Maxwell's equations; Contitutive Relations; Boundary conditions; Energy flux and conservation; Harmonic time dependence; Model for conductors, dielectrics and plasma. **Plane waves:** Plane waves in lossless and lossy media; Wave impedance; Polarization; Energy density and flux; Oblique incidence. **Radiation fields:** Fields of electric and magnetic dipoles; Radiation fields; Fields of linear, wire antennas. **Antenna parameters:** Directivity, gain, bandwidth; Effective area and effective length; Antenna and system noise. **Wire antennas:** Linear and dipole antennas; Vee, rhombic and loop antennas; Yagi (coupled) antennas. **Aperture antennas:** Horn antennas; Microstrip antennas; Parabolic reflector antennas; Lens antennas; **Antenna arrays:** Array pattern multiplication; Visible region; Grating lobes; Uniform arrays; Directivity, steering and beamwidth; Design.

**C. APPLICATIONS TOPICS**

The project will consist of one of the following topics

1. Design of a wire antennas
2. Radiation patterns for dipole and wire antennas (Matlab programming)
3. Radiation patterns for antenna arrays (Matlab programming)
4. Adaptive algoritm for antenna array beamsteering (Matlab programming)
5. Field simulation of a microstrip antenna (with a commercial EM solver)

**D. REFERENCES**


1. C. A. Balanis, *Antenna Theory: Analysis and Design*, New York: Wiley, 2005.
2. R. E. Collin, *Antennas and Radiowave Propagation*, New York: McGraw-Hill, 1985
3. S.J. Orfanidis, *Electromagnetic Waves and Antennas*, http://www.ece.rutgers.edu/~orfanidi/ewa/


## *ADVANCED TOPICS IN SIGNAL PROCESSING*

**A. COURSE OBJECTIVES**

This course is intended to give some knowledge and competences in using wavelets in signal processing. Another major goal of this course is to introduce the problem of statistical signal processing which means estimation and detection. These topics are present in almost all M.Sc. curricula, worldwide. The importance of using wavelets and statistical signal processing in communication engineering and other related fields is obvious. This course offers an essential support for other courses dealing with transmission over fading channels and also for the general theory of digital modulation.

**B. COURSE TOPICS**

**1. Wavelets.** The concept of multiresolution. Digital wavelet transform. Presentation and use of Wavelet toolbox and WaveLAB for 1D and 2D signals.

**2. Cramer-Rao Lower Bound.** Minimum Variance unbiased estimation; Cramer-Rao theorem. Some examples.

**3. Maximum Likelihood Estimation.** The likelihood function. The concept of estimation with maximum likelihood. Algorithms for ML estimation. Some examples.
**4. Least Squares Estimation.** The estimation problem in the case of lack of any statistical properties. Computer minimization techniques of the cost function. Basics on Kalman filtering. Some examples.
**5. Neyman-Pearson Detection Strategy.** The constant false alarm criterion. Detection threshold. Probability of correct detection. Some applications in image processing, database searching, RADAR/SONAR.
**6. Bayesian Detection Strategy.** The risk function. Detection using the minimum risk rule. ML Bayesian detection and MAP Bayesian detection. Examples of using the Bayesian strategy in communications. ML and MAP receivers.

**C. APPLICATIONS TOPICS**

Project can be on one of the following topics:

- Denoising using wavelets,
- Watermarking using wavelets,
- Inpainting using wavelets,
- Parameter estimation using Cramer-Rao techniques,
- Parameter estimation using ML techniques,
- Parameter estimation using LS techniques,
- Detection using Neyman-Pearson strategy in watermarking,
- Bayesian detection for communications.

The student will pick a journal paper or 2-3 conference papers from the course webpage (it is assumed that the student will also read back references to understand that paper).
Goals for the project are

* Reading the papers in full detail and needed back references,
* For the paper, the student will choose one part of the paper and simulate the proposed algorithm to re-generate the results given or try it on a related application,
* Make a short presentation explaining the ideas of the papers and what they obtain from the simulations and why
* Prepare a report explaining the above in more careful detail

Requested: WaveLAB or Wavelet toolbox for wavelets assignments. Simulations will be done in MATLAB or LabVIEW.

**D. REFERENCES**


1. Corina Nafornita, *Digital Watermarking in the Wavelet Domain*, Politehnica Publishing House, Timisoara, 2005, ISBN 973-625-236-1.
2. Corina Nafornita, *Signals and Systems, vol. 1*, Politehnica Publishing House, 2009, ISBN 978-606-554-013-2 (978-606-554-014-9 vol I).
3. Steven M. Kay, *Fundamentals of statistical signal processing,* Prentice Hall, 1993 (vol I) and 1998 (vol II).
4. Petre Stoica, Randolph Moses, *Spectral analysis of signals*, Prentice Hall, 2005.
5. Poor, H. V., *Introduction to Signal Detection and Estimation*, Springer; 2nd edition March 16, 1998), ISBN-10: 0387941738, ISBN-13: 978-0387941738.

## *SELECTED TOPICS IN COMMUNICATIONS ENGINEERING*

**A. COURSE OBJECTIVES**

This course presents an overview of modern communications technologies and challenges. The main objective is to provide knowledge for understanding the technological developments, that are at the heart of the proliferation and fusion of networks taking place today Another objective is providing skills in identifying problems and the appropriate method to be applied, especially in switching, routing and congestion control. It prepares students to understand the issues facing the designers of next-generation data networks and to undertake applied projects or research in the areas of communications network design.

**B. COURSE TOPICS**

**1. High speed 4G communications.** Characteristics of modern communications networks. Architectures. Technologies. Challenges. Long term evolution communications.

**2. Delay models in data networks** Multiplexing on a Communication Link. Queuing models. Queuing systems. Self-similarity traffic- and forecasting. Long range dependency communications.

**3**. **Multiaccess communication** Introduction on multi-access problem in satellite , radio, data an telephone communications. Splitting Algorithms.

**4. Routing**. Main Issues in Routing, An Overview of Routing in Practice. .Network Algorithms and Shortest Path Routing. Adaptive Routing Based on Shortest Paths Flow Models, Optimal Routing, and Topological Design. Optimisation of routing using intelligent techniques

**5. Congestion control**. Objectives. Window Flow Control. Flow Control Schemes Based on Input Rate Adjustment. Congestion control by using neural networks.

**C. APPLICATIONS TOPICS**

1.Packet Queuing and Scheduling
2. Ad hoc wireless network traffic-self-similarity and forecasting
2.Multiacces communications
3.Routing Algorithms
4.Intelligent routing
5.Congestion control using intelligent techniques
6.Border Gateway protocol routing
7.Long term evolution communications

**D. REFERENCES**


1. Dimitri Bertsekas, Robert Gallagher, *Data communications networks, 2nd edition*, Prentice Hall International, Inc. Englewood Cliffs, New Jersey, 1991
2. *William Stallings, Data and Computer Communications* (8th Edition), Prentice Hall, Inc, 2009
3. A. Leon-Garcia, I. Widjaja. *Communication Networks (2nd edition)*. McGraw-Hill, 2004
4. Deep Medhi, Karthik Ramasamy , *Network routing. Algorithms, Protocols, and Architectures*. Morgan Kaufmann Publishers, 2007

## *MODERN PROGRAMMING TECHNIQUES*

**A. COURSE OBJECTIVES**

The course provides a broad, solid understanding of essential Visual Basic topics. It describes the Visual Basic language itself and explains how to use it to perform a host of important development tasks. It also explains the forms, controls, and other objects that Visual Basic provides for building applications in a modern windowing environment. It does cover the majority of the technologies that developers need to build sophisticated applications.

**B. COURSE TOPICS**

1. Introducing .NET. The .NET Framework The Visual Basic Language. Types, Objects, and Namespaces.
2. Developing ASP.NET Applications. Visual Studio. Web Form Fundamentals. Web State Management. Error Handling, Logging, and Tracing. Deploying ASP.NET Applications
3. Data Types, Variables, and Constants. Operators
4. Subroutines and Functions. Inheritance Mode. Property Procedures. Extension Methods. Lambda Functions. Relaxed Delegates. Partial Methods
5. Program Control Statements. Decision Statements. Single Line If Then. Multiline If Then. Select Case. Enumerated Values. IIf. If. Choose. Looping Statements. For Next. Non-integer For Next Loops. For Each. Exit and Continue
6. Building Better Web Forms. Validation Rich Controls. User Controls and Graphics. Styles, Themes, and Master Pages. Website Navigation
7. Working with Data. ADO.NET Fundamentals. Data Binding. The Data Controls. Files and Streams.XML

**C. APPLICATIONS TOPICS**

1. Introduction to the IDE. Menus, Toolbars and Windows.
2. Visual Basic Code Editor. Debugging.
3. Selecting Windows Forms Controls. Using Windows Forms Controls. Windows Forms
4. Selecting WPF Controls . Using WPF Controls .WPF Windows
5. Database Controls and Objects
6. OOP Concepts. Classes and Structures. Namespaces. Collection Classes. Generics.
7. Graphics. Drawing Basics. Brushes, Pens, and Paths. Text. Image Processing. Printing. Reporting.
8. Interacting with the Environment. Configuration and Resources. Streams. File-System Objects. Windows Communication Foundation. Useful Namespaces.

**D. REFERENCES**


1. MacDonald Matthew, Beginning ASP.NET 3.5 in VB 2008, Apress, Springer Verlag, 2007.
2. Stephens Rod, Visual Basic® 2008. Programmer's Reference, Wiley Publishing, 2008.


## *PCBA DESIGN AND MANUFACTURING*

**A. COURSE OBJECTIVES**

- To provide advanced knowledge and skills about all relevant aspects

regarding the design, development and manufacturing of complex printed circuit board assemblies

- To provide basic knowledge about signal integrity and thermal management of electronic modules
- To introduce modeling and simulation techniques for virtual prototyping of printed circuit board assemblies

**B. COURSE TOPICS**

- An overview of electronic technologies
- Advanced packaging of electronic devices
- Printed circuit board manufacturing technologies
- Module assembly technologies
- Computer aided manufacturing
- Intelligent design of PCBA (aka: Design for Excellence)
- Signal integrity issues in PCB design
- Virtual prototyping for signal integrity
- Thermal management of electronic modules
- Virtual prototyping for thermal management

**C. APPLICATIONS TOPICS**

- Printed circuit board manufacturing technologies
- Computer aided manufacturing of PCBA
- Expert systems for intelligent design
- Electrical modeling of printed circuit boards
- Signal integrity analysis of printed circuit boards
- Power integrity analysis of printed circuit boards
- Thermal analysis of electronic modules

**D. REFERENCES**


1. Clyde F. COOMBS (ed.) Printed Circuits Handbook, McGraw Hill, 2001.
2. Glenn BLACKWELL (ed.), The Electronick Packaging Handbook CRC Press, 2000.
3. Joseph FJELSTAD, Flexible Circuit Technology, BR Publishing, 2006.
4. Happy HALDEN, The HDI Handbook, BR Publishing, 2009.
5. Rudolf STRAUSS, SMT Soldering Handbook, Newnes, 2008.
6. Ralph REMSBURG, Thermal Design of Electronic Equipment, CRC Press, 2001.
7. Stephen THIERAUF, High Speed Circuit Board Signal Integrity, Artech House, 2006.
8. Brian YOUNG, Digital Signal Integrity: Modeling and Simulation with Interconnects and Packages, Prentice Hall, 2001.


## ***MATHEMATICAL MORPHOLOGY***

**A. COURSE OBJECTIVES**

The course provides advanced theoretical foundations of mathematical morphology, a powerful framework for the analysis and processing of geometrical structures. Its main applications are signal processing, particularly image processing. Students following this course will acquire the ability to derive properties of morphological

operators, as well as the modelling skills needed in finding morphology based solutions to engineering problems.

**B. COURSE TOPICS**

Basic structures and operations
Properties of morphological operations
Derived morphological operators
Morphological filters
Morphological segmentation
Shape analysis using mathematical morphology

**C. APPLICATIONS TOPICS**

Dilation and erosion
Opening and closing transforms
Grey scale morphological filtering
Skeletons and thinning
Morphological gradients
Watershed segmentation
Shape analysis using mathematical morphology

**D. REFERENCES**


1. *Morphological Image Analysis; Principles and Applications* by Pierre Soille, ISBN 3540-65671-5 (1999), 2nd edition (2003)
2. *An Introduction to Morphological Image Processing* by Edward R. Dougherty, ISBN 0-8194-0845-X (1992)
3. Jean. Sera, "Mathematical Morphology Online Courses", http://cmm.ensmp.fr/~serra/cours/index.htm


## ***PATTERN RECOGNITION***

**A. COURSE OBJECTIVES**

The course addresses the main concepts in pattern recognition techniques from both theoretical and practical point of view. Our goal is to provide the knowledge needed to understand research papers and to solve practical pattern recognition applications.

**B. COURSE TOPICS**

Introduction
Bayesian Decision Theory
Maximum Likelihood and Bayesian Parameter Estimation
Nonparametric Techniques
Linear Discriminant Functions and Neural Networks
Feature Selection and Extraction
Machine Learning
Unsupervised Learning and Clustering

**C. APPLICATIONS TOPICS**

Image feature extraction
Normal BayesClassifier
K-Neares neighbour classifiers
Support Vector Machine Classifiers
Decision Trees
Boosting

Espectation Maximization
Neural Networks

**D. REFERENCES**


1. R.O.Duda, P.E.Hart, D.G. Stork, "Pattern Classification, 2nd Edition , Wiley 2000
2. C.M. Bishop, "Neural Networks for Pattern recognition", Oxford University Press, 2004.


## ***NETWORKS MODELING***

**A. COURSE OBJECTIVES**

The course has as main objectives the theoretical and practical aspects regarding telecommunications networks simulation in order to evaluate and optimize their performances. The students will gain insights in statistics and stocastic processes as well as modelling and simulation of discrete event systems. Techniques for analysing systems performances are also considered. The purpose of this lecture is to introduce simulation techniques as a necessary instrument for studying stochastic systems with discrete events.

**B. COURSE TOPICS**

**Stochastic processes used in modelling:** Basis concepts; Properties; Markov model;

**Queueing systems simulation:** Introduction to queueing systems theory; Service processes; Poisson processes; Exponential negative law;

**Traffic clasification:** Traffic in circuits switched systems;Traffic in packet switched systems: Data traffic at packet level; Data traffic at flow level(TCP and UDP);

**Models**:Poisson model- Application to flow level modelling of streaming data traffic, Erlang model- Application to telephone traffic modeling in trunk network, Binomial model, Engset model-Application to telephone traffic modelling in acces network; Queueing model – Application to packet level modelling of data traffic;Sharing systems-Application to flow level modelling of elastic data trafic;

**Queueing networks**: Burke's theoreme; Exponential servers chain; The G/D/1 chain;

**Telecommunications networks modelling:** Stochastic networks; Open networks, Jackson networks

**Simulation of systems with multiple series servers;** Applications in telecommunications networks performance evaluation and design;

**C. APPLICATIONS TOPICS**

Laboratory no. 1. Arrival processes models;
Laboratory no.2. Performance evaluation in different traffic models: Erlang model, Engset model, Binomial model Sharing model;
Laboratory no.3. Taylor software presentation;
Laboratory no.4. Simulation and performance evaluation of the M/M/1/N system
Laboratory no.5. Continuous processes modeling;
Laboratory no.6. Performance parameters evaluation;

**D. REFERENCES**


1. Recent Advances in Modeling and Simulation Tools for Communication Networks and Services, Nejat Ince (Author, Editor), Arnold Bragg (Editor)

2. J. F. Hayes, Thimma V. J., Gannesh Babu, *Modeling and analysis of Telecommunications networks*, Wiley, 2004
3. G. Fiche, G. Hebuterne, *Trafic et performances des reseaux de telecoms*; GET et Lavoisier, Paris, 2003.
4. 3.G. Niculescu, *Analiza şi modelarea sistemelor de comunicaţii*; Editura Matrix Rom; Bucureşti 1997.
5. H. Akimaru, K. Kawashima, *Teletrafic. Theory and Applications*; Springer-Verlag; Berlin Heidelberg, New York, 1993.

## ***VIDEO NETWORKS***

**A. COURSE OBJECTIVES**

Introduction to video signal and digitization parameters. Presenting the compression and transmission techniques. Presenting the MPEG4, H.264, MPEG7 and MPEG21 standards.

**B. COURSE TOPICS**

**Baseband signals:** Voice, Image, Video, Data; **Compression techniques:** Lossless compression, Lossy compression; **Video Compression:** Video formats, Quality assessment (Subjective methods, Objective methods), Video coding concepts (Video CODEC, Temporal model, Image model, Entropy coding, The hybrid DPCM/DCT video codec model, Video coding standards) ; **The MPEG4 Visual standard:** Basic concepts (tools, objects, profiles and levels), Coding rectangular frames, Coding arbitrary shaped regions, Scalable video coding and scalable profiles, Texture coding, Studio quality video profiles, Coding synthetic visual scenes; **The H.264 standard:** Basic concepts, H.264 structure, H.264 profiles; **The MPEG7 and MPEG21 standards:** Characteristics, Structure.

**C. APPLICATIONS TOPICS**

Manipulating image data using Visual C++ and OpenCV; Accessing square blocks within an image; The forward Discrete Cosine Transform; The inverse DCT; Quantization; Coefficients reordering and RLE; RLE decoding and restoring coefficients order; Entropy coding; Entropy decoding; The Discrete Wavelet Transform.

**D. REFERENCES**

1. Iain E. G. Richardson, *H.264 and MPEG-4 Video Compression – Video Coding for Next-generation Multimedia;* John Wiley & Sons; England, 2003
2. M. Oteşteanu*, Sisteme de transmisie şi comutaţie;* Editura Orizonturi Universitare; Timişoara, 2001

## ***NETWORK PLANNING***

**A. COURSE OBJECTIVES**

The lectures contain the basic principles of Radio network planning. Radio links engineering and radio coverage topics are presented. Applications for different types of Mobile networks are also explained and developed.

**B. COURSE TOPICS**

1. Intro Radio Network Planning and Optimisation
2. Radio site engineering
3. Microwave link engineering

4. Mobile Radio Channel and Fading
5. Radio Link Engineering in Mobile Networks
6. Link budgets for GSM, UMTS and LTE
7. Radio coverage aspects
8. Outdoor and indoor propagation models
9. Geospatial data for Network planning

**C. APPLICATIONS TOPICS**

The main laboratory works cover: Microwave links design, Link budget calculations for different radio technologies, Propagation models principles and software implementation, Coverage planning.

Laboratory works are held in GSM lab which contains equipment from Alcatel

**D. REFERENCES**


1. **Mobile Radio Networks**, B.H. Walke, John Wiley & Sons, 2000, (electronic form).
2. **Fundamentals of Wireless Communication**, D. Tse, P. Viswanath, Cambridge University Press 2005, (electronic form).
3. **Advanced Cellular Network Planning and Optimisation** Edited by Ajay R Mishra**,** John Wiley & Sons Ltd, 2007.
4. Mobile Communications **(in romanian), E. Marza, C.Simu, Editura de Vest, Timisoara 2003, (20 copies in library).**


## ***COMPUTER NETWORKS ADMINISTRATION***

**A. COURSE OBJECTIVES**

The main goal of this discipline is to endow students with theoretical and practical knowledge regarding computer networks administration and management. The main objectives of the course classes are to prepare students to understand and practice network administration, network requirements estimation and allocation, network setup, network security, and network management.

**B. COURSE TOPICS**

1. **Introduction in network administration**: computer networks fundamentals, TCP/IP networks, network administration (2h)
2. **Design, install and configure computer networks**: network design, planning, equipments' setup, OS configuration, documentation (2h)
3. **Routing**: Routing protocols, Routing rules, balancing network utilization (2h)
4. **Network applications and services**: DNS, DHCP, WINS, SMTP, POP/IMAP, HTTP, FTP (3h)
5. **Directory services**: LDAP, ActiveDirectory, Authentication and authorization (3h)
6. **Security policies**: security planning, security monitoring, access control (2h)
7. **Network security**: firewall, VPN, IPSec, anti-virus, anti-spam (2h)
8. **Network management**: SNMP, CMIP, MIB, SNMP (4h)
9. **Wireless networks administration**: standards, design rules, equipments, security (2h)
10. **Quality of services**: QoS, ToS, MPLS, SLA. (2h)
11. **Network troubleshooting**: network tools, test cases, service validation (2h)

12. **Intranet and Internet services configuration and administration**: IIS, Apache, applicaton services. (2h)

**C. APPLICATIONS TOPICS**

1. Network planning, installing and setup
2. Monitoring network protocols: Whireshark
3. Network management - D-View
4. SNMP & MIB
5. VPN setup
6. AD setup
7. Firewall setup
8. IIS/Apache setup
9. Email server setup
10. Routing protocols
11. Security policies
12. WLAN setup

**D. REFERENCES**


1. Craig Hunt, TCP/IP Network Administration, 3rd Edition, O'Reilly, 2002.
2. Roberta Bragg, Craig Hunt, Windows Server 2003 Network Administration, O'Reilly, 2005.
3. Mark Burgess, Principles of Network and System Administration, John Wiley and Sons, 2004.


## ***MOBILE COMMUNICATION NETWORKS***

**A. COURSE OBJECTIVES**

The course provides technical information about the most important aspects of 3GPP LTE according to release 8 specification, from basic concepts to advanced topics and future directions.

**B. COURSE TOPICS**

The context for the Long Term Evolution of UMTS.

System architecture based on 3GPP SAE. Network architecture and protocols. LTE Radio Protocols. Control plane protocols. User plane protocols.

OFDM, OFDMA and wider-band single-carrier transmission. Channel Coding and Link Adaptation.

Physical Layer for downlink and uplink. Physical data and control channels.

Scheduling, link adaptation and hybrid ARQ. Multi-user scheduling and interference coordination.

Radio resource management.

Multi-antenna techniques: MIMO in LTE.

User mobility.

Power control.

Voice service in LTE. Voice over IP (VoIP)

LTE-Advanced. Performance of 3G evolution

**C. APPLICATIONS TOPICS**

The students should elaborate a semester project on an individual theme according to the course topics.

**D. REFERENCES**


1. H. Holma, A. Toskala (editors), **LTE for UMTS – OFDMA and SC-FDMA Based Radio Access**, John Wiley & Sons, 2009
2. F. Khan, **LTE for 4G Mobile Broadband. Air Interface Technologies and Performance**, Cambridge University Press 2009
3. E. Dahlman, S. Parkvall, J. Sköld and P. Beming, **3G Evolution HSPA and LTE for Mobile Broadband**, Second edition, Elsevier, 2008.


## ***OPTICAL COMMUNICATION SYSTEMS AND NETWORKS***

**A. COURSE OBJECTIVES**

The main objective of this course is to give the student the ability to analyse and design optical systems and networks. The course will emphasize the physical properties and operation of components that comprise optical systems (fiber, semiconductor lasers, photodetectors, etc.) and optical networks (optical couplers, optical amplifiers, WDM components etc.). The basic elements of optical network operation will also be described, taking into account the constraints of the physical layer, the type of traffic to be transported and the upper level protocols. To get this objective the course starts by covering first generation optical systems and networks, where the optical technology is limited by transmission (FDDI, SONET). The second generation networks (SONET next generation, WDM) are then covered in detail, starting with the study of optical network elements needed for the implementation of all-optical network nodes.

**B. COURSE TOPICS**

Outline syllabus:

Cap.1 Introduction.

Cap.2 Fiber optical lines, physical level : Basics of numerical communication in optical channel (models, attenuation , dispertion, noise,etc.); Fibers and optical devices (optical fibers, emitters, receeivers,couplers etc.); Line WDM systems (components and design).

Cap.3 Optical networks: Optical network topology: Optical network devices (star couplers, optical switches,etc.).

Cap4. Optical network design:Client models; Routing and traffic models; Optimization algorithms and methods

(Routing algorithms, Integral software control, Heuristical algorithms and optimization).

Cap.5 Software control for optical networks: Software control of large transport networks; MPLambdaS /GMPLS; rapidly reconfigurable optical networks.

Cap.6 Optical networks: FDDI; SONET/SDH and SONET next generation; WDM metropolitan optical networks.

**C. APPLICATIONS TOPICS**

Laboratory: Network fiber optical devices; FDDI; SONET/SDH; Measuring methods for fiber optical systems and networks.

Project: MatLab models for optical fiber systems and networks devices.

**D. REFERENCES**


1. Rajiv Ramaswami and Kumar Sivarajan, Optical Networks Second Ed., 2002, Morgan Kaufmann Publishers

2. Jun Zheng,H.T.Mouftah,Optical WDM Networks,2004,IEEE Press.
3. Adrian Mihaescu ,Comunicaţii Optice,2005,Editura de Vest,Timişoara.

## *RESOURCE MANAGEMENT IN WIRELESS NETWORKS*

**A. COURSE OBJECTIVES**

The main objective of the course is to present the concept of Radio Resources Management in wireless networks, consisting in a set of strategies and algorithms for controlling some important parameters, in order to utilize the limited radio spectrum resources and radio network infrastructure as efficiently as possible and to improve Quality of Service and general system performance in wireless networks.

**B. COURSE TOPICS**

Radio resources management (RRM) in wireless networks. Radio Resource concept. Radio planning, network planning, adaptive system management.

Resources management in 2G systems. RRM in GSM-GPRS/EDGE wireless networks.

Resources management in 3G systems. RRM in WCDMA. RRM functions. Admission control, Congestion control, Code management, Handover, Power control, MAC and packet scheduling, Interactions among RRM functions. System characteristics relevant at RRM level. RRM Algorithms.

Radio Resource Management in WiMAX. Frequency band allocation. Link budget. Call Admission Control1. Handover in WiMAX. Modulation Schemes in WiMAX.

Radio Resource Management in LTE. Specific aspects of RRM for LTE. Dynamic packet assignment–scheduling; link adaptation and power allocation; handover control; intercell interference coordination; load balancing; MIMO configuration control.

**C. APPLICATIONS TOPICS**

The students, forming groups of 2-3, will have to make and sustain a semester project based on one of the courses topics.

**D. REFERENCES**

1. P.-R. Jordi, S. Oriol, A. Ramon, Radio **Resource Management Strategies in UMTS**, John Wiley & Sons, 2005.
2. Jens Zander, Radio **Resource Management for Wireless Networks**, Artech House; 2001
3. Sofoklis A. Kyriazakos, **Practical Radio Resource Management in Wireless Systems**, Artech House, 2004
4. N. D. Tripathi, J. H. Reed, **Radio Resource Management in Cellular Systems**, Kluwer Academic Publishers, 2001.

## *BROADBAND COMMUNICATION NETWORKS*

**A. COURSE OBJECTIVES**

The course has as main objective to supply the main benefits of wideband and ultra-wideband and to present theoretical and technological problems which appear in practical implementations especially in wireless communications. Also it is presented the potential of this technology in localization, including time of arrival (TOA) estimation, positioning approaches, and positioning accuracy analysis.

**B. COURSE TOPICS**

1. Introductions. Applications. Antennas. Propagations and Channel Model. Receiver structures ( 6 hours)
2. Modulation and Signal Detections ( 3 hours)
3. Mixed Signal Wideband Communications Receivers ( 4 hours)
4. Analog / Digital Ultra-Wideband Transceivers and Digital Receivers ( 6 hours)
5. Digital carrier spreading codes for base band wideband access ( 3 hours)
6. Pulsed wideband interference to narrowband receivers ( 3 hours)
7. Localization ( 3 hours)

**C. APPLICATIONS TOPICS**

1. Simulation of types of wideband modulations
    - single carrier based modulation
    - OFDM based modulation
2. Wideband pulse propagation and detection
    - generalized multipath model
    - IEEE 802.15.4.a channel model
    - Optimum receiver
3. Digital carrier spreading codes for base band wideband multiaccess
    - digital carrier mutiband user codes
    - low duty cycle access in presence of NBI rate access in presence of multipath

**D. REFERENCES**


1. Xuemin Shen ed. “Ultra-wideband wireless communications and networks”, John Wiley & Sons Ltd 2006
2. Jeffrey Reed ed: “An Introduction to Ultra Wideband Communications Systems”, Prentice Hall, 2005.
3. W. Pam Siriwongpairat, K. J. Ray Liu, "Ultra-Wideband Communications Systems : Multiband OFDM Approach" Wiley-IEEE Press


## ***ADVANCED MULTIMEDIA TECHNOLOGIES***

**A. COURSE OBJECTIVES**

The course objective is to provide advanced theoretical information of the scientific area, with a strong emphasize for up –to-date technology development. The course goal is to provide information, knowledge in updated technologies used in e-commerce, e-learning and e-government, on the convergence between Internet and mobile communication technologies, as well as the technical presentation of the Information Society technologies.

**B. COURSE TOPICS**

Tendencies regarding multimedia technologies evolution
Structure tasks and user adaptability
Advanced technologies and software for multimedia applications
Advanced Web programming
HCI (Human Computer Interaction): definition and concepts, implementation strategies
Software Engineering
Mobile multimedia technologies

Infrastructure multimedia technologies
Multimedia applications engineering
Interactive-TV, WebCast, DVB, DAB, Video On Demand
Communication media convergence
Internet security protocols

**C. APPLICATIONS TOPICS**

Case studies – electronic payment systems, smart-card security, e-leaning, e-voting, e-gouverment
– multimedia infrastructure applications' testing
– software testing (including CGI and API scripts)

**D. REFERENCES**


1. N. Chapman, J. Chapman – Digital Multimedia, Wiley, 2001
2. J. Watkinson – Convergence in Broadcast si Communications Media, Focal Press, 2001
3. F. Halsall – Multimedia Communications, Addison Wesley, 2001
4. R. S. Tannenbaum – Theoretical Foundations of Multimedia, Comp. Science Press, 1998
5. England, Elaine, Finney, Andy, *Managing Multimedia, Project Management for Interactive Media*, second edition, Addison Wesley Longman Limited, Harlow, England, 1999, ISBN 0-201-36058-6
6. Pirouz, Raymond, Weinman, Lynda, *Click Here, Web Communication Design*, New Riders Publishing, Indianapolis, USA, 1997, ISBN 1-56205-792-8


## ***SPECTRAL ANALYSIS AND ESTIMATION***

**A. COURSE OBJECTIVES**

Introduction of advanced topics in frequency repesentation of signals; non-parametric and parametric estimation techniques and algorithms for quantities related to the frequency representation of signals. The course is motivated by recent developments of the field and its applications in communications, measurement, speech processing, automation, imaging etc.

**B. COURSE TOPICS**

**Introduction:** Overview of the field and its applications; Random signals: power, spectral density and coherency; Cramer-Rao lower bound. **Nonparametric spectrum estimation methods:** Periodogram, corelogram, FFT, sampling, windowing, zero-padding: Bias and variance. **Parametric methods for line spectra:** Models for sinusoids in noise, nonlinear least squares method, Pisarenko method, Yule-Walker method etc. **Parametric methods for rational spectra:** AR, MA and ARMA signals; Yule-Walker method, Levinson-Durbin algorithm, Subspace parameter estimation;

**C. APPLICATIONS TOPICS**

The project will consist of Matlab implementation of a package of algorithms for spectral analysis:

1. FFT and periodograms
2. AR, MA and ARMA processes
3. Pisarenko method
4. The Yule-Walker method

5. The Levinson-Durbin algorithm
6. Adaptive algorithms.

**D. REFERENCES**


1. P. Stoica, R. Moses, *Introduction to Spectral Analysis,* Englewood Cliffs NJ:1997.
2. S.M. Kay, *Modern Spectral Estimation: Theory and Applications,* Englewood Cliffs NJ: Prentice Hall, 2000.
3. P.M.T. Broersen, *Automatic Autocorrelation and Spectral Analysis,* London: Springer, *2006*.