Syllabus

Discipline name	Optoelectronic Systems in Telecommunications
Profile	Electronics and Telecommunications Engineering
Specialization	Telecommunications Technologies and Systems
Code	51324909-2
Course leader	Professor Emil Voiculescu, Ph.D., emil.voiculescu@bel.utcluj.ro
Collaborators	Assistant Professor Ramona Galatus, Ph.D., ramona.galatus@bel.utcluj.ro Assistant Lorant Szolga, Lorant.Szolga@bel.utcluj.ro
Department	Basis of Electronics
Faculty	Electronics, Telecommunications and Information Technology

Sem.	Type of Course	Lectures	Labs			Lectures	Labs			Home Learning	TOTAL	Credits	Final test
		[hours/week]				[hrs/sem]							
			S	L	P		S	L	P				
7	**Speciality**	**2**	**-**	**2**	**-**	**28**	**-**	**28**	**-**	**64**	**120**	**4**	**Exam**

Acquired competences:

Course Description

Upon completion, the students will be able to understand optoelectronic devices and optical integrated passive and active components used in modern industrial and communication systems. Emphasis is given to the design and analysis of optical devices circuits, and their applications in communications and optical signal processing; how the optical signal is transmitted in optical network (WDM, DWDM).

Course Learning Objectives

After completing the discipline, the students will be able to:

- use a specific tool for optical system design (VPIPhotonics)
- use a specific tool for optical components simulation (Liekki)
- design an optical network system based on required conditions (three design methods)
- know different fiber types, connectors, components
- work with HFC network equipment
- work with fiber splicer
- analyze level map (layout) with optical fiber network equipments
- analyze OTDR files with specific event storage on optical fiber network link

Prerequisites (if necessary)

Optoelectronics Course

A. Lectures	
1	Light propagation in free space, light guides, propagation modes. Transmission system modelling.
2	Optical fibers : configuration, index profiles, light attenuation. The telecom wavelength ranges. Optical fiber manufacturing.
3	Photonic sources : LEDs, LDs, modulating semiconductor lasers. The lasing condition, the resonance equation, efficiency.
4	Lasers for telecom : VCSELs, DFB/ DBRs, external cavity lasers, tunable leasers, fiber lasers. Drivers.
5	Photodetectors *pin*, APD : basics, SNR (signal per noise ratio), pin-diode response.
6	Step index optical fiber. Guide dispersion, material dispersion, DSF (dispersion shifted fibers), flat dispersion fibers. Graded index fibers. Modes, trajectories, dispersion compensation. Single-mode fiber : the electromagnetic field, optical power, MFD (mode field diameter), effective area.
7	Types of fibers and optical cables. Comparative analysis, specifying optical fibers and cables. Connectors, splicing techniques.
8	Optical isolators, polarisers, circulators, multiplexers, AWG routers. Structure, operation, engineering.
9	Optical resonators. Fabry-Perot resonators.
10	In-fiber gratings. Filters using IFG. Diffraction gratings on 2D / 3D wave guides.
11	Fiber transmitters : structure, operation, single-multi mode coupling with the fiber, pigtailing. Fiber receivers for digital communication systems: noise, diode-preamplifiers, eye-diagram, detection threshold. Operation, structure, engineering.
12	Fiber communication systems. Point to point links. Long-houl transmission. Distance between repeaters-regenerators. Flux budget, SNR, BER.
13	Optical networks. Fiber to the home, building, curb. Gigabit Ethernet on Fiber to the Home. Cable networks (video, data – CaTV). Sizing the link based on signal-map, attenuation and dispersion (Ericsson).
14	14. Fiber lasers and optical amplifiers. Fiber amplifiers and semiconductor optical amplifiers. Their role in optical communication systems.

Syllabus

B1. Lab activity (list of applications)	
1	Introduction. Optical theory review. Lab instrumentation. Work security rules. 2D and 3D step-index waveguides TE and TM modes.
2	Mode coupling study in parallel waveguides. Bragg Diffraction Gratings.
3	Mach-Zender interferometer as electro-optic modulator– static and dynamic regime.
4	Optical system design (Budget flux equation) methods, based on Thorlabs catalog.
5	Basics of Fiber propagations – VPI University Curricula
6	Chromatic Dispersion and Kerr Nonlinearities - VPI University Curricula
7	Polarisation Effect - VPI University Curricula
8	Introduction to Fiber-Optic Communications 1+2. BER and Q factors. - VPI University Curricula
9	Optical Emitters- VPI University Curricula
10	Optical Receivers. Photonics measurements. - VPI University Curricula
11	Optical Amplifier- VPI University Curricula
12	WDM systems- VPI University Curricula
13	HFC network
14	Student's evaluation (1hour). OTDR presentation, as a device for optical network troubleshooting events monitoring.
B2. Laboratory (Room/area, adress) Room 328, Baritiu 27, 35m^2	

C. Individual study (reference study contents, synthesis materials, projects, applications etc.)						
Course slides, multimedia materials, essay (course homework)						
Individual study structure	Course study	Problem solving, laboratory, project	Applications preparation	Examination time	Additional reference study	Total no. of individual study hours
Hours	28	4	20	3	9	64

References

UTC-N Library

1. Emil Voiculescu, Tiberiu Marita - *Optoelectronica*, Editura Albastra, 2001, ISBN 973-9443-96-6
2. Emil Voiculescu, Lucian Rotaru,ş.a.–*Comunicatii pe fibra optica.Indrumător de laborator*, U.T. PRES, 2003
3. Niculae Puscas – Sisteme de Comunicatii Optice, Editura Matrix, Bucuresti, 2006, ISBN (10)973-755-021-8
4. Niculae N. Puscas – Fizica Dispozitivelor Optoelectronice Integrate, Ed. ALL Educational, Bucuresti, 1998, ISBN 973-9937-60-0
5. Walter Ciciora, s.a., Modern Cable Television Technology: Video, Voice and Data Communications, 2nd ed., Morgan Kaufmann Publishers, 2004
6. Govind P. Agrawal, Fiber-Optic Communications, 3rd ed., John Wiley&Sons, Inc 2002
7. Achyut K. Dutta, s.a.- WDM TECHNOLOGIES: OPTICAL NETWORKS, vol 3, Elsevier Pub., Academic Press, 2004
8. Duwayne R. Anderson- **Troubleshooting Optical-Fiber Networks**- Understanding and Using Your, Optical Time-Domain Reflecto-meter, Elsevier Pub., Academic Press, 2004

Multimedia course materials

1.Voiculescu E. – PPT lecture files

2. ***Others***

1. Photonics Spectra, Lasers, IEEE Photonics Technology, IEEE Journal of Quantum Electronics
2. Harry J.R. Dutton - Understanding Optical Communications, IBM RedBook, http://www.redbooks.ibm.com

Final evaluation	
Evaluation method	Written exam (E): problem solving (70%) and theoretical subjects (30%) (2 hours). After lecture 7 it can be sustain a partial exam-PE (1.5 hours) consists of a synthesis material.
Mark components	Exam (E: 0…10 points); Laboratory (L: 0…10 points); Partial exam (PE: 0…10 points).
Mark computation	M = 0.5E + 0.1L + 0.4PE. Pass if: E≥4.5 and L≥4.5 and M≥4.5

Course leader,

Professor Emil VOICULESCU, Ph.D.