University of Tehran
School of Electrical and Computer Engineering

Course:	**8101705 – Software-Defined Radio Laboratory**		
Course type:	Elective	EE*	Credit: 1
Level:	Undergraduate and Graduate		
Co-requisite(s):	-		
Prerequisite(s):	Communications Systems II (8101355)		
Prerequisite by topic:	Basic concepts of analog and digital modulation techniques, Basic concepts of digital signal processing.		
Textbook(s):	[1] J. S. Harsini, M. Amirrahmat, F. Lahouti, *Digital Communications Lab Manual,* School of E&CE, University of Tehran, 2011.		
Coordinator:	Vahid Shah-Mansouri, Assistant Professor, School of ECE		
Goals:	This lab course provides students with opportunities to deepen their understanding of the theory of communication systems through hands on experiments. To this end, they simulate and build real-time digital communication systems using Simulink and a software-defined radio platform. The experiments involve both analog and digital modulation and practical considerations such as timing, phase, and frequency recovery in digital data transmission. Moreover, they understand the design trade-offs involved in the performance of real world communication systems.		
Outcome:	Upon successful completion of the course, students will be able to 1. understand the structure of a software-defined radio (SDR) system 2. understand the design trade-offs involved in the performance of analog and digital communication systems. 3. simulate and implement a SDR based digital transceiver (transmitter/receiver) system for analog modulation techniques (linear and nonlinear); And to compare the performance of different digital AM/SSB/FM detectors. 4. simulate and implement a SDR based digital transceiver (transmitter/receiver) system for digital modulation techniques (BPSK/QPSK). 5. simulate and implement some basic feed-forward and feedback (PLL) timing/frequency/phase recovery algorithms for real world transceiver systems. 6. design and implement a simple frame synchronization scheme		

	for digital image transmission.
Topics:	1. Getting familiar with software-defined radio platform and MATLAB-Simulink. 2. Digital implementation of analog linear modulation techniques: AM/DSB/SSB 3. Digital implementation of analog non-linear modulation techniques: Feed-forward FM detectors 4. Digital implementation of analog non-linear modulation techniques: PLL-based FM detector 5. Simulation of the BPSK/QPSK transceivers with perfect synchronization, optimum receiver, and pulse shaping 6. Simulation of the BPSK/QPSK transceivers with timing phase recovery: squaring and early-late timing recovery algorithms 7. Simulation of the BPSK/QPSK transceivers with carrier (frequency & phase) recovery: feed-forward and PLL-based carrier recovery algorithms 8. Implementation of the BPSK/QPSK transceivers: application to digital image transmission
Computer usage:	MATLAB and Simulink
Assignments:	Several assignments per lab experiment (mostly done in the lab)
Projects:	One final project (case by case basis as applicable)
Grading:	Lab exercises, activity and participation: 35% Lab reports, exam, project: 65%
Further readings:	[1] W. H. Tranter, K. S. Shanmugan, T. S. Rappaport, and K. L. Kosbar, *Principles of communication systems simulation with wireless applications*, Upper Saddle River, NJ: Prentice-Hall, 2004. [2] D. Silage, *Digital communication systems using MATLAB and Simulink*, Bookstand Publishing, Philadelphia, USA, 2009. [3] U. Mengali and A. N. D'Andrea. *Synchronization Techniques for Digital Receivers*. Plenum Press, New York, 1997. [4] Roland E. Best, *Phase-Locked Loops: Design, Simulation, and Applications*. McGraw-Hill, 5th ed., New York, NY, 2003. [5] H. Meyr, M. Moeneclaey, and S. A. Fechtel, *Digital Communication Receivers: Synchronization, Channel Estimation, and Signal Processing*, John Wiley & Sons, Inc., New York, NY, 1998.
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*EE: Electrical Engineering CE: Computer Engineering IT: Information Technology