National University of Sciences & Technology (NUST)
School of Electrical Engineering and Computer Science (SEECS)
Department of Electrical Engineering

EE-351: Communication Systems			
Course Code:	EE-351	**Semester:**	6th
Credit Hours:	3+1	**Prerequisite Codes:**	Signals & Systems
Instructor:	Huma Ghafoor	**Class:**	BEE – 12C
Office:	C-202 UG Block	**Telephone:**	051-90852104
Lecture Days:	As per timetable	**E-mail:**	huma.ghafoor@seecs.edu.pk
Class Room:	As per timetable	**Consulting Hours:**	Appointment through email
Lab Engineer:	Fatima Fayaz	**Lab Engineer Email:**	fatima.fayaz@seecs.edu.pk
Knowledge Group:	STSN	**Updates on LMS:**	End of Week

Course Description:

This course familiarizes the students with the principles of communication systems and their applications in telephone, radio, television, and computer communications. The course primarily consists of Analog Communication Systems and is supplemented with introduction to Digital Communication Systems. We start with a brief review of Fourier series and Fourier transform. Basic analog communication systems, including AM and FM systems are covered next. Signal-to-noise-ratio in (SNR), in AM and FM systems, is also covered. Then, transition towards digital communication systems is made gradually with A/D conversion process, pulse modulation schemes and finally PCM. At each level, system design is given primary importance by using examples from practical systems. Digital Transmission and Reception are covered next. Finally, a brief introduction will be given to the Digital Modulation schemes and digital multiplexing standard.

Course Learning Outcomes:

CLO	Description After the completion of the course the students will be able to:	BT Level	PLOs
1.	**Determine** whether a mathematical representation of a signal is an AM signal, a DSB signal, a SSB signal, an FM signal, or a PM signal	C4	2
2.	**Analyze** and compare various analog/digital communication systems, their properties and behavior in the presence of noise	C4	2
3.	**Describe** the concepts of Matched filter detectors, Digital Multiplexing and Digital Modulation techniques.	C2	1
4.	**Conduct** experiments as well as **analyze** and **interpret** experimental data	P4	4
5.	**Design** a communication system under certain constraints and requirements	P4	3
6.	**Execute** system design using Labvolt Analog and Digital Communication boards at the block level	P4	5
7.	**Exhibit** good professional and ethical behavior while **adhering** to lab safety rules.	A3	8
8.	**Function** effectively both individually and as a member of a team	A3	9

Mapping of CLOs to Program Learning Outcomes

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6	CLO7	CLO8
PLO 1 (Engineering Knowledge)			√					
PLO 2 (Problem Analysis)	√	√						
PLO 3 (Design/Development of Solutions)					√			
PLO 4 (Investigation)				√				
PLO 5 (Modern tool usage)						√		
PLO 6 (The Engineer and Society)								
PLO 7 (Environment and Sustainability)								
PLO 8 (Ethics)							√	
PLO 9 (Individual and Team Work)								√
PLO 10 (Communication)								
PLO 11 (Project Management)								
PLO 12 (Lifelong Learning)								

Assessment Modules, Weightages, and Mapping to CLOs

Assessments/CLOs	CLO1	CLO2	CLO3	CLO4	CLO5	CLO6	CLO7	CLO8
Assignments + Quizzes: 20% of the theory part	√	√	√					√
Project: 25% of the lab part		√			√			√
Mid: 30% of the theory part	√	√	√					
Labs: Lab work 75% and exam 25% of the course				√	√	√	√	√
End Semester Exam: 50% of theory part	√	√	√					

Books:

Text Books:

1. An Introduction to Analog and Digital Communications, 2nd Edition by Simon Haykin and Michael Moher
2. B. P. Lathi, "Modern Digital and Analog Communication Systems," 4th Edition, Adapted by Hari M. Gupta, 2017, Oxford University Press.

Reference Books:

1. Introduction to Communication Systems by Ferral G. Stremler
2. Analog and Digital Communication Systems by Martin S. Roden
3. Communication System by John G. Proakis and Masoud Salehi

Topics to be Covered:

Introduction to Communication Systems	**Angle Modulation**
Motivation	Frequency Modulation (FM)
Review of Fourier Series and Fourier Transform	Phase Modulation (PM)
Energy and Power Signals	Phase-Locked Loop (PLL)
Energy / Power Spectral Density	Performance of FM systems in noise
Amplitude Modulation	**Analog to Digital Conversion**
Double Sideband Suppressed Carrier (DSB-SC)	Sampling
Amplitude Modulation (DSB-LC)	Quantization
Single Sideband (SSB) Modulation	Pulse Code Modulation (PCM, DPCM, DM)
Vestigial Sideband (VSB) Modulation	Noise in Digital Communications
Performance of AM systems in noise	

	Lecture Breakdown	
Textbook	**Topics**	**Lectures**
	Introduction to Communication Systems	
2	Motivation, Components	1
	Analysis of Signals	
2	Energy and Power Signals	1
2	Fourier Series and Transform, Linear Time Invariant Systems	1
	Amplitude Modulation	
1	Spectrum of an AM Signal	1
1	Envelope Detection, Power of an AM Signal, Efficiency of an AM Signal	2
	Double Sideband Modulation Double Sideband Suppressed Carrier (DSB-SC) Coherent Detector, Costas Receiver	1
1	Costas Receiver + Problems	2
1	Quadrature Carrier Multiplexing (QCM)	1
1	Single Sideband Modulation, types	1
1	Vestigial Sideband Modulation	2
1	Complex Envelope	1
	Angle Modulation	
1	Frequency Modulation (FM)	1
1	Phase Modulation (PM), Generation Methods	1
1,2	Numericals	2
1,2	Generation Methods Cont., Wideband FM Signal, Carson's Rule	1
1	FM, PM Demodulation (Cont.)	1
1	FM, PM Demodulation (Cont.)	1
1,2	Simple Slope Detector, Balanced Slope Detector	1
1,2	Phase-locked Loop	1
1,2	Numericals	2
2	FM broadcasting	1
1,2	AM Receivers + Numericals	1
1,2	Numericals	2
	Analog to Digital Conversion	
1	Sampling Theorem, Aliasing	1
1	Interpolation + Numericals	2
1	Pulse Code Modulation (PCM, DM)	1
1,2	**Digital Communications**, Pulse Modulation Techniques (PAM, PWM, PPM)	1
1	Quantization	1
1	Quantization Error, Companding	1
1,2	Optimal Quantizer	2
1,2	Differential Pulse Code Modulation	1
1	Distortion and Noise, DM	1
1	Noise in Analog Communications + Numericals	4
	REVIEW	4
	Total:	48

Lab Experiments:
EXP-1: Analog Communication Concepts, Circuit Board Familiarization.
EXP-2: Balanced Modulator.
EXP-3: AM Transmission, Amplitude Modulation, and RF Power Amplifier.
EXP-4: AM Reception: RF Stage, Mixer, IF Filter, Envelop detector
EXP-5: SSB Transmission, Balance Modulator and LSB Filter, Mixer and RF Power Amplifier.
EXP-6: SSB Reception
EXP-7: Frequency and Phase Modulation and Demodulation (Quadrature detector).
EXP-8:. Phase-Locked Loop (PLL) Circuit and Operation, FM Detection with a PLL.
EXP-9: Digital Board Familiarization
EXP-10:. Pulse amplitude modulation (PAM) Signal Generation, PAM Signal Demodulation
EXP-11:. PAM Time Division Multiplexing (PAM-TDM) Transmission, PAM-TDM Reception.
EXP-12: Pulse Code Modulation (PCM) Signal Generation and Demodulation
EXP-13: Line Coding, Encoding, Decoding
EXP-14: Digital Board-2 Familiarization
Exp-15: Amplitude Shift Keying Generation and Detection
Exp-16: Frequency Shift Keying Generation and Detection

Tools / Software Requirement:
Analog and Digital Communication boards are required for practical work. The boards and all the relevant software have been installed in the lab. MATLAB can be used for practice and for semester projects.

Grading Policy:	
Quiz Policy:	The quizzes will be unannounced and normally last for ten minutes. The question framed is to test the concepts involved in last few lectures. Number of quizzes that will be used for evaluation is at the instructor's discretion. Grading for quizzes will be on a fixed scale of 0 to 10. A score of 10 indicates an exceptional attempt towards the answer and a score of 1 indicates your answer is entirely wrong but you made a reasonable effort towards the solution. Scores in between indicate very good (8-9), good (6-7), satisfactory (4-5), and poor (2-3) attempt. Failure to make a reasonable effort to answer a question scores a 0.
Assignment Policy:	In order to develop comprehensive understanding of the subject, assignments will be given. Late assignments will not be accepted / graded. All assignments will count towards the total (No 'best-of' policy). The students are advised to do the assignment themselves. Copying of assignments is highly discouraged and violations will be dealt with severely by referring any occurrences to the disciplinary committee. The questions in the assignment are meant to be challenging to give students confidence and extensive knowledge about the subject matter and enable them to prepare for the exams.
Lab Conduct:	The labs will be conducted for three hours every week. A lab handout will be given in advance for study and analysis The lab handouts will also be placed on LMS. The students are to submit their results by giving a lab report at the end of lab for evaluation. One lab report per group will be required. However, students will also be evaluated by oral viva during the lab.
Plagiarism:	SEECS maintains a zero tolerance policy towards plagiarism. While collaboration in this course is highly encouraged, you must ensure that you do not claim other people's work/ ideas as your own. Plagiarism occurs when the words, ideas, assertions, theories, figures, images, programming codes of others are presented as your own work. You must cite and acknowledge all sources of information in your assignments. Failing to comply with the SEECS plagiarism policy will lead to strict penalties including zero marks in assignments and referral to the academic coordination office for disciplinary action.