EEE451 – DIGITAL COMMUNICATION SYSTEMS

Course Code	Course Name		Semester	
EEE451	Digital Communication Systems		Fall ☒ Spring ☐ Summer ☐	
Hours			**Credit**	**ECTS**
Theory	**Practice**	**Lab**	3	4
3	0	0		

Course Details	
Department	Electrical and Electronics Engineering
Course Language	English
Course Level	Undergraduate ☒ Graduate ☐
Mode of Delivery	Face to Face ☒ Online ☐ Hybrid ☐
Course Type	Compulsory ☐ Elective ☒
Lecturer(s)	Prof. Dr. Yalçın Ata
Course Objectives	The objective of this course is to provide students with a thorough understanding of the fundamental principles and advanced techniques used in digital communication systems. Students will learn to analyze and evaluate digital modulation schemes, understand the impact of noise, interference, and distortion on system performance, and apply mathematical models and algorithms to assess system efficiency. The course will also cover key concepts such as error detection and correction, synchronization, and channel coding. By the end of the course, students will be equipped with the skills to design and optimize digital communication systems, with a focus on real-world applications and performance analysis. Additionally, students will gain hands-on experience in simulation and problem-solving, preparing them for further study in advanced communication technologies, including wireless and optical communication systems.
Course Content	The course will cover the following topics: an introduction to digital communication systems, including the basic components and the difference between analog and digital communication; signal representation and spectral analysis, focusing on Fourier transforms and power spectral density; baseband transmission, including pulse shaping, Nyquist criterion, and ISI mitigation; digital modulation techniques such as ASK, FSK, PSK, and QAM, along with their comparisons; channel models and noise, examining AWGN; error detection and correction methods, including parity checks, CRC, Hamming codes, Reed-Solomon codes, and convolutional codes; performance analysis of digital communication systems in terms of bit error rate (BER), symbol error rate (SER), and error probability; synchronization techniques for time, symbol, and carrier synchronization.

Course Method/ Techniques	Lecture ☒ Question & Answer ☒ Presentation ☐ Discussion ☐
Prerequisites/ Corequisites	
Work Placement(s)	

Textbook/References/Materials

- B. P. Lathi and Z. Ding, *Modern Digital and Analog Communication Systems*, 4th ed. Oxford University Press, 2010.
- J. G. Proakis, *Digital Communications*. 4th ed. New York, NY: McGraw-Hill, 2000.

Course Category				
Mathematics and Basic Sciences	☐		Education	☐
Engineering	☒		Science	☐
Engineering Design	☐		Health	☐
Social Sciences	☐		Profession	☐

Weekly Schedule

No	Topics	Materials/Notes
1	Introduction, Sampling theorem	Chapter 6 (Lathi)
2	Pulse code modulation (PCM), digital multiplexing	Chapter 6 (Lathi)
3	Digital communication systems, line coding, pulse shaping	Chapter 7 (Lathi)
4	Digital receivers, repeaters and M-ary baseband signaling	Chapter 7 (Lathi)
5	Performance analysis for digital communication systems, linear detector for binary signaling, binary signaling, coherent receivers	Chapter 10 (Lathi)
6	Performance analysis for digital communication systems, signal space analysis, receiver for white Gausian noise channels	Chapter 10 (Lathi)
7	Performance analysis for digital communication systems,error probability of optimum receivers, noncoherent detection, non-white channel noise	Chapter 10 (Lathi)
8	Digial communications under linearly distortive channels, distortions, receiver channel equalization, equalizers	Chapter 12 (Lathi)
9	Midterm Exam	-
10	Digial communications under linearly distortive channels, OFDM communications	Chapter 12 (Lathi)
11	Information theory, source encoding, error free communication, channel capacity	Chapter 13 (Lathi)
12	Midterm Exam	-
13	Information theory, channel capacity, multiple-input multiple-output systems	Chapter 13 (Lathi)
14	Error correction codes, redundancy, linear block codes, convolutional codes	Chapter 14 (Lathi)
15	Error correction codes, trellis diagram, decoding, turbo codes, LDPC codes	Chapter 14 (Lathi)

16	Final Exam	-

Assessment Methods and Criteria		
In-term studies	**Quantity**	**Percentage**
Attendance		
Lab		
Practice		
Fieldwork		
Course-specific internship		
Quiz/Studio/Criticize		
Homework	3	20
Presentation / Seminar		
Project		
Report		
Seminar		
Midterm Exam	2	40
Final Exam	1	40
	Total	**100%**
Contribution of Midterm Studies to Success Grade		60
Contribution of End of Semester Studies to Success Grade		40
	Total	**100%**

ECTS Allocated Based on Student Workload			
Activities	**Quantity**	**Duration (Hrs)**	**Total Workload**
Course Hours	16	3	48
Lab			
Practice			
Fieldwork			
Course-specific Work Placement			
Out-of-class study time			
Quiz/Studio/Criticize			
Homework	3	5	15
Presentation / Seminar			
Project			
Report			
Midterm Exam and Preparation for Midterm	2	15	30
Final Exam and Preparation for Final Exam	1	20	20
Total Workload			**113**
Total Workload / 25			**4.52**
ECTS Credit			**4**

Course Learning Outcomes	
No	**Outcome**
L1	Explain the sampling theory, PCM, and Principles of Data Transmission.
L2	Illustrate the digital modulation and detection techniques, and compare and contrast between the various line codes.
L3	Analyze the functionality of each block in simple digital communication system, explain the overall integration of the different blocks, explain the functionality of the whole system, and link its various blocks to the basic mathematical and signal operations.
L4	Identify the effect of Gaussian noise on the performance of digital communication system, and calculate the bit error rate.
L5	Analyze the performance of digital communication system in the presence of AWGN noise.
L6	Categorize the block coding schemes / algorithms for bit error detection and correction
L7	Design a simple experimental setup in the form of a Digital Communication System to transmit an analog message

Contribution of Course Learning Outcomes to Program Competencies/Outcomes

Contribution Level: 1: Very Slight, 2: Slight, 3: Moderate, 4: Significant, 5: Very Significant

	P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**					**Total**
L1	4	5	4	4	2	1	X	X	X	X	X					-
L2	4	5	4	4	2	1	X	X	X	X	X					-
L3	4	4	3	3	3	1	X	X	X	X	X					-
L4	4	4	4	4	2	1	X	X	X	X	X					-
L5	2	4	4	2	1	1	X	X	X	X	X					-
L6	3	3	4	4	2	1	X	X	X	X	X					-
L7	5	4	2	2	1	1	X	X	X	X	X					-
															Total	-

i. Sufficient knowledge in the fields of mathematics, natural sciences, and related engineering disciplines; the ability to apply theoretical and practical knowledge in solving complex engineering problems.

ii. The ability to identify, formulate, and solve complex engineering problems; the ability to select and apply appropriate analysis and modeling methods for this purpose.

iii. The ability to design a complex system, process, device, or product to meet specific requirements under realistic constraints and conditions; the ability to apply modern design methods for this purpose.

iv. The ability to select and use modern techniques and tools required for the analysis and solution of complex problems encountered in engineering applications; the ability to effectively use information technologies.

v. The ability to design experiments, conduct experiments, collect data, analyze results, and interpret findings for the investigation of complex engineering problems or discipline-specific research topics.

vi. The ability to work effectively in intra-disciplinary and multidisciplinary teams; the ability to work independently.

vii. The ability to communicate effectively both orally and in writing; proficiency in at least one foreign language; the ability to write effective reports, understand written reports, prepare design and production reports, make effective presentations, and give and receive clear and understandable instructions.

viii. Awareness of the necessity of lifelong learning; the ability to access information, track developments in science and technology, and continuously renew oneself.

ix. Acting in accordance with ethical principles, knowledge of professional and ethical responsibilities, and the standards used in engineering applications.

x. Knowledge of business practices such as project management, risk management, and change management; awareness of entrepreneurship and innovation; knowledge of sustainable development.

xi. Knowledge of the impact of engineering practices on health, environment, and safety at global and societal levels, and awareness of contemporary engineering issues; awareness of the legal consequences of engineering solutions.