Module (Course Syllabus) Catalogue

2023-2024

College/ Institute	Technology college				
Department	Information and Communication Technology Engineering (ICTE)				
Module Name	DIGITAL COMMUNICATION				
Module Code	DIC404				
Degree	Technical Diploma ✓			Bachelor ✓	
	High Diploma		Master		PhD
Semester	4th semester				
Qualification	Electrical and Electronic Engineering				
Scientific Title	Assistant Lecturer				
ECTS (Credits)	5				
Module type	Prerequisite		Core ✓		Assist.
Weekly hours	4				
Weekly hours (Theory)	(2)hr Class		(135)Total hrs Workload		
Weekly hours (Practical)	(2)hr Class		(135) Total hrs Workload		
Number of Weeks	12				
Lecturer (Theory)	Jabbar Majeed Sadeq				
E-Mail & Mobile NO.	jabbar.sadeq@epu.edu.iq		07504487044		
Lecturer (Practical)	Jabbar Majeed Sadeq				
E-Mail & Mobile NO.	jabbar.sadeq@epu.edu.iq		07504487044		
Websites					

Course Book

Course Description	This course is a graduate-level introduction to the basic principles of digital communication systems. A digital communication system is one that transmits a source (voice, video, data, etc.) from one point to another, by first converting it into a stream of bits, and then into symbols that can be transmitted over channels (cable, wireless, storage, etc.). The use of the digital bit-stream as the interface between the source and the channel is universal regardless of what kind of source and channel are involved. Digital communication principle, with "bit" as the most important concept of the information age, and applications in computer science, Internet, wireless, etc., is one of the most successful stories of applying mathematics in engineering designs. Also, this course describes the fundamentals of digital modulation and demodulation, Analog to digital converters, ASK, FSK PSK, and pulse code modulation and demodulation and PAM, PWM, PPM.
Course objectives	**To understand the key modules of digital communication systems with an emphasis on digital modulation techniques**. To get introduced to the concept and basics of information theory and the basics of source and channel coding/decoding.
Student's obligation	The student should be attended to the class every week for four hours and prepare himself for weekly quizzes and do assignments and home works in the theory class and must write a report for every experiment done weekly in the laboratory.
Required Learning Materials	1- Powerpoint presentation 2-white board 3- sheets 3- seminars zoom meeting and Moodle program.

	Task		Weight (Marks)	Due Week	Relevant Learning Outcome
	Paper Review				
	Assignments	Homework	5	3-6-9-12	Telecommunication system outcomes
		Class Activity	2	Overall weeks	Basic of digital to Analog and Analog to digital converters
		Report			
		Seminar	10	6	Seminar on digital communication techniques
		Essay			
		Project		6-11	
	Quiz		8	Every week	Weekly quizzes

	Lab.	10	Overall weeks	Every week report about the experiments done in the laboratory
	Midterm Exam	25	12	
	Final Exam	40	15	All the outcomes
	Total	100		
Specific learning outcome:	On completion of this course the students will be able to: • Analyze digital communications in the time domain and frequency domain. • Distinguish between different Digital modulation techniques. • Understand the importance of error considerations in communication systems. • Understanding the importance of Digital to Analog conversion • Understanding the modulation and demodulation techniques of Digital communication • Understanding the effect of noise on the transmitted signal to the receiver during the medium.			
Course References:	1- Electronic communications by M. LANDA 2- Local area networks by GRED 3- Digital communication by: A.Glover&P.M Grant 4- Modern communication circuits by: J.Smith 5- Electronic communication www.electronic.com 6- Mobile communications www. google			

Course topics (Theory)	Week	Learning Outcome
Principles of digital communication: bit rate, baud rate, signal length	1	Understanding the principles of digital communication
Amplitude, Frequency, phase Shift Keying, and quadrature amplitude modulation	2	Modulation Techniques
Amplitude, Frequency, phase Shift Keying, and quadrature amplitude demodulation	3	Demodulation techniques
Uniform Pulse code modulation, Sampling Theorem.	4	Uniform Pulse code modulation techniques
Uniform Quantization, S/N ratio error power Quantization calculation	5	Understanding how to calculate error power Quantization
Delta modulation and demodulation	6	Understanding principles of Delta modulation and demodulation
Differential Pulse Code Modulation (DPCM) and demodulation	7	Understanding the Differential Pulse Code Modulation (DPCM) and demodulation

PAM, PWM, PPM Modulation techniques	8	Understanding the PWM, PAM, and PPM techniques
Quadrature amplitude modulation is a combination of ASK and PSK.	9	Understanding the principle of QAM
Constellation Diagrams	10	Students can sketch constellation diagram
constellation diagrams for an ASK (OOK), BPSK, and QPSK signals	11	constellation diagrams for an ASK (OOK), BPSK, and QPSK signals
Satellite communication	12	To understand the satellite principle

Practical Topics	**Week**	**Learning Outcome**
Amplitude Shift keying modulation Experiment	1	Students understand how to design an ASK modulation circuit
Amplitude Shift keying demodulation Experiment	2	Students understand to design ASK demodulation circuit
Frequency shift keying modulation Experiment	3	Students understand to design FSK modulation circuit
Frequency Shift keying demodulation Experiment	4	Students understand to design FSK demodulation circuit
Phase shift keying modulation experiment	5	Students understand to design a PSK modulation circuit
Phase shift keying modulation experiment	6	Students understand to design a PSK demodulation circuit
Pulse code modulation experiment	7	Students understand to design a PCM modulation circuit
Pulse code demodulation experiment	8	Students understand to design a PCM demodulation circuit
Pulse amplitude modulation and demodulation experiment	9	Students understand to design a PAM modulation and demodulation circuit
Pulse width modulation and demodulation experiment	10	Students understand to design a PWM modulation and demodulation circuit
Pulse position modulation and demodulation experiment	11	Students understand to design a PPM modulation and demodulation circuit
Frequency division multiplexing access experiment	12	Students understand to design an FDMA modulation and demodulation circuit

Questions Example Design

19. Examinations:

Q1/ Choose the correct answer for each of the following statements:

1. a) Frequency b) Square of frequency c) Square of amplitude d) Amplitude
2. Pulse width modulation is also called.....modulation.
   a) Pulse position b) Pulse code c) Pulse duration d) Pulse delta
3. The satellite is in orbit somewhere between 8000 km and 18000 km above the earth's surface is:
   a) Molniya orbit satellite b) Geostationary earth orbit c) Low earth orbit d) Medium earth orbit
4. Quadrature Amplitude Modulation (QAM) has the same advantages as.....

ASK and FSK b) ASK and PSK c) FSK and PSK d) All the above.

5. ASK, PSK, FSK, and QAM is examples of.....conversion.

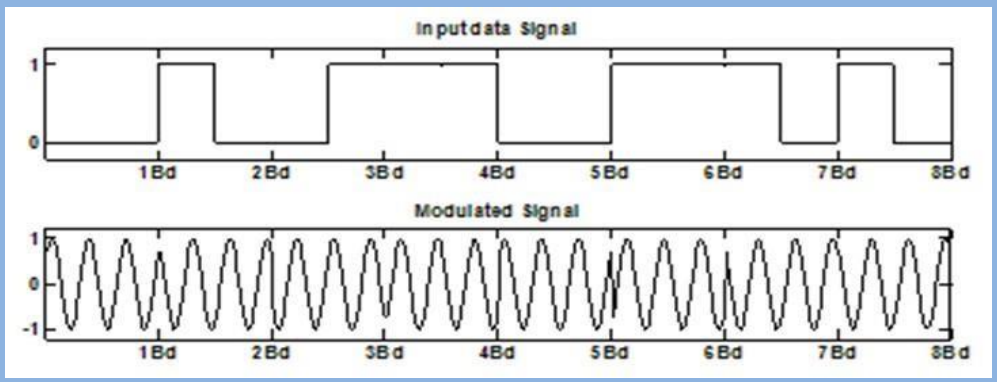
Digital to digital b) Analog to digital c) Analog to analog d) Digital to analog.

6. Which of the following techniques uses digital modulation?
   a) PAM b) PWM c) PPM d) PCM
7. What type of modulation does the figure below indicate?

Pulse width modulation b) Unipolar PAM c) Bipolar PAM d) Pulse position modulation

8. What type of analog modulation does the figure below indicate?

ASK b) PSK c) FSK d) QAM



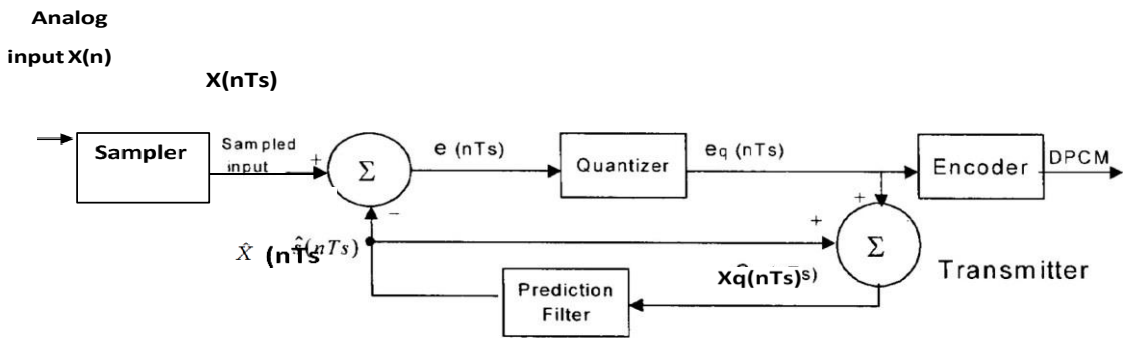
Q2/ If $V_m(t) = 5\cos(2\pi\, 4.2\times10^{6}(t))V$, is pulse code modulated **(PCM)** with quantizing level **(M = 6)**

1- Calculate Code word length.

2-Calculate bit rate.

3-Output signal to quantization noise ratio in decibels. If the signal power=0.05

Example: Consider the input samples $X_{(n)} = \{3.1,3.2,3.3,3.5,3.6,3.7,3.8\}$. Explain how encoding and decoding is done on DPCM, Assume the first order filter $\hat{X}(nTs)=X_q(n-1)$



Encoder:

e(nTS)= X(nTs) - $\hat{X}$ (nTs)

Xq(nTs) = $\hat{X}$ (nTs)+e_q(nTs)

X(n)	$\hat{X}$ (nTs)=Xq(n-1)	e(nTs) X(n) - $\hat{X}$ (nTs)	eq(nTs)	Xq(nTs)= $\hat{X}$ (nTs)+eq(nTs)
4.1	0 initially	4.1-0=4.1	4	0+4=4
4.2	4	4.2-4=0.2	0	4+0=4
4.3	4	4.3-4=0.3	0	4+0=4
4.4	4	4.4-4=0.4	0	4+0=4
4.5	4	4.5-4= 0.5	1	4+1=5
4.6	5	4.6-5=-0.4	0	5+0=5
4.7	5	4.7-5=-0.3	0	5+0=5
4.8	5	4.8-5=-0.2	0	5+0=5

Transmitter sequences

4	0	0	0	1	0	0	0
100	000	000	000	001	000	000	000

Q3/

Audio signal band-limited to (300 to 3300 Hz) is sampled at a sampling rate 8k sample per sec.

The required $(SNR)_o = 30$ dB

(a) What is the number of levels **L** needed and what is n_{min} needed?

(b) Calculate the minimum system bandwidth required.

(c) Repeat parts (a) and (b) when $\mu = 255$ and μ -law compander is used.

Solution

(a) Using single tone test equation

$$(SNR_o)_{dB} = 1.76 + 20 \log L \geq 30$$

$$\log L \geq \frac{30 - 1.76}{20} = 1.412 \Rightarrow L \geq 25.82 \quad or \quad L = 26$$

Thus the minimum word length (n) needed

$$n_{\min} = \log_2 L = \log_2 26 = 4.7 \Rightarrow n = 5$$

$$n_{\min} = 5 \; bit / sample$$

$$(b)\; f_{PCM} = \frac{nf_s}{2} = \frac{5 \times 8000}{2} = 20kHz$$

$$(c)\; \alpha = 10 \log \{3/[\ln(256)]^2\} = -10.1$$

$$(SNR_o)_{dB} = 20 \log L - 10.1 \geq 30$$

$$\log L = \frac{40.1}{20} = 2.005 \Rightarrow L = 2^{2.005} = 101.2$$

The minimum number of levels

$$L_{\min} = 102$$

$$n = \log_2 L = 6.67$$

The min number of bits n = 7

$$f_{PCM} = \frac{nf_s}{2} = \frac{7 \times 8000}{2} = 28 \; kHz$$

20. Extra notes:

Extra notes:
External Evaluator 1- The course book of Digital communication is completely related to the syllabus of Digital communication, the practical syllabus satisfies the goal of digital communication subjects. 2- The practical course is completely defined by the theoretical lectures. Assist Prof. Dr. Raghad Zuhair Yousif: Lecturer at the ICTE department