SYLLABUS

1. **Course name:** Digital Communication
2. **Course code:** DICO432264
3. **Credits:** 3 credits (3/0/6) (3 theoretical credits, 0 practical credit)

   Duration: 15 weeks (3 main periods and 6 self-study periods) /week)
4. **Instructors:**
   a. Primary instructor: Pham Ngoc Son, Ph.D
   b. Secondary instructors:
      - Phan Van Ca, Ph.D
      - Dang Phuoc Hai Trang, MEng
5. **Course conditions**

   Prerequisites: N/A.
   Corequisites: Data Communication, Signal and System.
6. **Course Description :**

This course provides fundamental knowledge about transmitting and receiving of digital communication, and elements of a modern digital communication system. In which, the course focuses signal representations, modulation techniques, coherent and incoherent demodulations, performance analyzation and optimal receiver design. Some basic concepts of information theory, probability and random process are also presented in the course. Besides, the course will introduce topics about multi-carrier signal transmission, ISI, equalizer, channel coding using in digital communication systems.

7. **Course Goals:**

Goals	*Goal description* *(This course provides students:)*	ELOs
G1	Ability to apply knowledge about mathematics, probability, signal to recognize, analyse exactitude or approximation, and evaluate digital communication systems.	01 (H)
G2	Ability to realize, calculate, use formula of Shanon capacity, Nyquist theorem, coding and solve problems of bit error, symbol error, average capacity, outage probability … and ability to design a digital communication system.	02 (M)
G3	Ability to use Matlab, Mathematica software in simulating, analyzing, and solving problems of performance.	03 (M)
G4	Ability to self-study and learn more about advanced techniques.	07 (M)
G5	Ability to present application about analyzing digital system.	10 (L) 11 (H)

** Note: H: **H**igh; M: **M**edium; L: **L**ow*

8. **Course Learning Outcomes - CLOs:**

CLOs		*Description* *(After completing this course, students can have:)*	Outcome
G1	G1.1	Understand concepts in digital communication.	01
	G1.2	Solve problems about probability in technology.	01
	G1.3	Understand and apply information theory and coding.	01

	G1.4	Use mathematics knowledge in analyzing and representing signal.	01
	G1.5	Understand and apply mathematics transformer in processing and analyzing data.	01
G2	G2.1	Apply Nyquist and Shanon sampling theorems.	02
	G2.2	Analyze basis of signal demodulation.	02
	G2.3	Analyze performance of digital communication.	02
	G2.4	Analyze coding technique.	02
G3	G3.1	Calculate performances: BER, PER, average capacity.	03
	G3.2	Detect data from received code.	03
G4	G4.1	Learn about codes: Gray, Convolutional code, Turbo.	07
	G4.2	Understand OFDM	07
	G4.3	Compare modulation and coding techniques.	07
G5	G5.1	Present and design optimal receiver architecture.	11
	G5.2	Understand strong points of digital communication system when comparing with analog system.	10,11

9. Study materials:

a. Textbooks:

[1] J. Proakis and M. Salehi, *Digital Communications*, Fifth Edition, Mc Graw-Hill, 2008.

b. References:

[2] U. Madhow, *Fundamentals of Digital Communication*, Cambridge University Press, 2008.

[3] S. G. Wilson, *Digital Modulation and Coding*, Prentice-Hall, 1996.

10. Student Assessments:

a. Grading points: 10

b. Planning for students assessment is followed:

Type	**Contents**	**Linetime**	**Assessment techniques**	**CLOs**	**Rates (%)**
		Midterms			**50**
Q	Knowledge of all chapters.	Week 2-15	Individual paper test in class	G1.1, G1.2, G1.3, G2.1, G4.3	20
M.1	Enegery and spectrum performance of modulation techniques.	Week 6	Individual paper test in class	G1.2, G1.4, G1.5, G2.1, G2.2, G2.3, G3.1, G4.3	15
M.2	Design optimal receiver and calculate BER of system.	Week 9	Individual paper test in class	G1.3, G2.4, G3.2, G5.1, G5.2	15
		Final exam			**50**
F	Content includes all output standards of the course.		Individual paper assessment in class		50

** Note: Q: **Q**uiz; H: **H**omework; P: **P**roject; M: **M**idterm Exam; F: **F**inal Exam;*

11. Course details:

Week	Contents	CLOs
1	***Chapter 1. Introduction of Digital communication** (3/0/6)*	
	Teaching contents: *(3)* 1.1 General model of a digital communication system 1.2 Components of a digital communication system **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.1, G1.3, G5.2
	Self-study contents: *(6)* 1.3 Advantage of digital communication system	
2	***Chapter 2. Probability and random process** (3/0/6)*	
	Teaching contents: *(3)* 2.1 Concepts of probability, random variable 2.2 Probability density and cumulative distribution function 2.3 Random process **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.2, G1.5, G2.3, G3.1
	Self-study contents: *(6)* 2.4 Some useful probability distributions	
3	***Chapter 3. Introduction of Information theory** (3/0/6)*	
	Teaching contents: *(3)* 3.1 Shanon theory 3.2 Coding **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.3, G2.1
	Self-study contents: *(6)* 3.3 Some common encoders	
4	***Chapter 4. Quantization and source coding** (3/0/6)*	
	Teaching contents: *(3)* 2.1 Sampling and Quantization 2.2 Source coding **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.4, G1.5, G2.1, G2.4
	Self-study contents: *(6)* 2.3 Nonlinear quantization methods	
5	***Chapter 5. Signal Space approach and Gram Schmidt Procedure** (3/0/6)*	
	Teaching contents: *(3)* 5.1 Modulation principle and representations of modulated signals 5.2 Representations of bandpass signals 5.3 Signal space and Gram-Schmidt procedure **Teaching methods**:	G1.4, G1.5, G2.2, G4.3

	+ Theoretical lectures + Questions and discussion **Self-study contents**: *(6)* 5.4 Basis of bandpass signal representation	
6	***Chapter 6:*** **Pulse shaping, bandwith efficiencys and demodulation** *(3/0/6)*	
	Teaching contents: *(3)* 3.1 Bandwith and pulse design standard 3.2 MAP and ML decision rule **Teaching methods**: + Theoretical lectures + Questions and discussion **Self-study contents**: *(6)* 3.3 Signal representations with noise	G1.5, G2.2, G2.3, 3.1, 5.1
7	***Chapter 7:*** **Optimal receiver design** *(3/0/6)*	
	Teaching contents: *(3)* 7.1 Optimal receiver design 7.2 Analyzing performance of system with AGWN channel **Teaching methods**: + Theoretical lectures + Questions and discussion **Self-study contents**: *(6)* 7.3 Using Matlab to simulate optimal receiver	G2.2, G3.1, G5.1
8	***Chapter 8:*** **Caculating error probabilty of optimal receiver** *(3/0/6)*	
	Teaching contents: *(3)* 8.1. Caculating error probabilty of different modulation types. 8.2. Approximaion in error probability calculation **Teaching methods**: + Theoretical lectures + Questions and discussion **Self-study contents**: *(6)* *8.3.* Using Matlab to simulate and analyze bit and symbol error	G1.2, G1.4, G1.5, G2.3, G3.1
9	***Chapter 9:*** **Approximate method in analyzing error probability** *(3/0/6)*	
	Teaching contents: *(3)* 9.1 Basis of approximate calculation 9.2 Approximate method 9.3 Using approximation to calculate error probability of different modulation types **Teaching methods**: + Theoretical lectures + Presentation, questions and discussion **Self-study contents**: *(6)* 9.4 Using Matlab to compare exactitude with approximation of bit/symbol error	G1.2, G1.4, G1.5, G2.3, G3.1
10	***Chapter 10: Non-coherent demodulation*** *(3/0/6)*	
	Teaching contents: *(3)* 10.1 Types of non-coherent demodulation	G1.5, G2.2, G2.3, G3.2,

	10.2 Structure and operation of non-coherent receiver 10.3 Performance analyzation **Teaching methods**: + Theoretical lectures + Presentation, questions and discussion **Self-study contents**: *(6)* 10.4 Comparing non-coherent demodulation with different demodulation types.	G4.3
11	***Chapter 11: MSK, analyze: BER, PER*** *(3/0/6)*	
	Teaching contents: *(3)* 11.1 Forms of MSK 11.2 MSK demodulation **Teaching methods**: + Theoretical lectures + Presentation, questions and discussion **Self-study contents**: *(6)* 11.3 Gray coding	G1.1, G1.2, G2.1, G2.2, G2.3, G3.1, G3.2, G4.1, G4,2, G4.3.
12	***Chapter 11: MSK, analyze: BER, PER (cont.)*** *(6/0/12)*	
	Teaching contents: *(3)* 11.4 MSK demodulation 11.5 Performance analyzation: BER, PER **Teaching methods**: + Theoretical lectures + Presentation, questions and discussion. **Self-study contents**: *(6)* 11.6 OFDM	G1.4, G4.1, G4.3, G5.1
13	***Chapter 12:*** **Channel capacity and coding** *(3/0/6)*	
	Teaching contents: *(3)* 12.1 Capacity and how to calculate capacity 12.2 Channel coding and types of channel coding 12.3 Block code **Teaching methods**: + Theoretical lectures + Presentation, questions and discussion. **Self-study contents**: *(6)* 12.4 Convolutional code	G1.4, G1.5, G2.3, G2.4, G3.1, G4.1
14	***Chapter 13:*** **Block code: Performance evaluation** *(3/0/6)*	
	Teaching contents: *(3)* 13.1 Performing block code architectures 13.2 Hamming code 13.3 Performance analyzation **Teaching methods**: + Theoretical lectures + Presentation, questions and discussion **Self-study contents**: *(6)* 13.4 Convolutional code	G1.3, G2.4, G3.1, G3.2

15	***Review***

12. Learning ethics:

- Home assignments and projects must be done by the students themselves. Plagiarism found in the assessments will get zero point

13. First approved date: January 15 2012

14. Approval level:

Dean	Department	Instructor
Nguyen Minh Tam, Ph.D	**Nguyen Ngo Lam, MEng**	**Phan Van Ca, Ph.D**

15. Syllabus updated process

1st time: Updated content dated **2nd time:** Updated content dated	Instructors Head of department