SYLLABUS

1. **Course name:** Wireless Communication Systems
2. **Course code:** WICS431364
3. **Credits:** 3 (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:
      - Pham Hong Lien, Assoc. Prof., Ph.D
      - Phan Van Ca, Ph.D
      - Le Minh Thanh, MEng.
5. **Course conditions**
   Prerequisites: Communication system
   Corequisites: N/A
6. **Course description**

This course provides students the knowledge of advanced wireless communication systems. Content of course: diversity techniques; MIMO; OFDM; satellite and viba transmission systems; principle, fundamental parts, operation of mobile communication systems such as GSM, WCDMA and LTE; technical solutions for the 5^{th} mobile system, as well as advanced solutions in wireless communication and some typical applications of wireless network. Tools and Mathematical models are used to help students understand operation methods of communication systems and know how to evaluate performance of a communication system.

7. **Course Goals**

Goals	***Goal description*** *(This course provides students:)*	**ELOs**
G1	Specialized knowledge in area of wireless technologies and analytical methods used in wireless communication systems; concepts, techniques and trends of future communication system.	01 (H)
G2	Ability to analyze and evaluate performance of a wireless solution; and ability to propose another proposal in communication systems.	02 (M)
G3	Ability to use Matlab and Mathematica software to simulate and analyze wireless communication models.	03 (M)
G4	Self-study ability.	07 (M)
G5	Ability to install, configure, operate, trouble shoot communication systems.	11 (M)

** Note: High: H; Medium: M; Low: L*

8. **Course Learning Outcomes (CLOs)**

CLOs	***Description*** *(After completing this course, students can have:)*	**Outcome**

G1	G1.1	Describe methods of diversity, new modulation technologies such as OFDM, MIMO.	01, 07
	G1.2	Present architecture and operation principle of mobile networks such as GSM, 3G WCDMA and 4G LTE.	01, 07
	G1.3	Evaluate performance, safety, frequency reuse, energy harvesting of wireless systems.	01, 02, 07
	G1.4	Describe development trends of techniques that can be used in 5G systems and ability to increase transmission rate.	01, 07
	G1.5	Present viba and satellite transmissions, and operation of wireless LAN, MANET, VANET, wireless sensor network.	01, 07
G2		Analyze and evaluate wireless communication systems in order to enhance performance.	02, 03
G3		Use Matlab and Mathematica software to calculate, solve, simulate and analyze performance.	03
G4	G4.1	Describe relationship between rate and bandwidth, and reason about development of 5G mobile system.	07
	G4.2	Describe function of each type of wireless network.	07
	G4.3	Evaluate new technique solutions.	07
G5		Describe installation, configuration, operation, trouble shooting in GSM, 3G WCDMA, 3G LTE and viba networks.	11

9. Study materials

- Textbooks:

[1] Andreas F. Molisch, *Wireless communications*, 2nd Ed., John Wiley & Sons, 2011

- References:

[1] Lê Tiến Thường, *Hệ thống viễn thông 2*, NXB ĐHQG TP. HCM, 2010

[2] Behrouz A. Forouzan, *Data Communicationsand Networking*

[3] Nasir, A.A., Xiangyun, Z., Durrani, S.,et al.: '*Relaying protocols for wireless energy harvesting and information processing*', IEEE Trans. Wirel. Commun., 2013,12, (7), pp. 3622–3636.

[4] P. N. Son, D. Har and H. Y. Kong, "*Smart Power Allocation for Secrecy Transmission in Reciprocally Cooperative Spectrum Sharing*," IEEE Transactions on Vehicular Technology, vol. 64, no. 11, pp. 5395-5400, Nov. 2015.

[5] Long Bao Le, Vincent Lau, Eduard Jorswieck, Ngoc-Dung Dao, Afshin Haghighat, Dong In Kim, Tho Le-Ngoc, ''*Enabling 5G mobile wireless technologies* '', EURASIP Journal on Wireless Communications and Networking, December 2015, 2015:218.

10. Student Assessments

- Grading points: 10

- Planning for students assessment is followed:

Type	Contents	Linetime	Assessment techniques	CLOs	Rates (%)
Midterms					**50**
S	Test students about ability to search, filter, solve and evaluate them through topics of wireless matters.	Weeks 2-14	Students perform and report topics.	G2, G3, G4.1, 4.2, G4.3, G5	20
M.1	Include knowledge in 1-3 chapters.	Week 8	Individual paper test in class	G1.1, G1.2,	15

				G1.3, G4.2	
M.2	Include knowledge in 4-6 chapters.	Week 13	Individual paper test in class	G1.4, G1.5, G4.1, G4.2	15
Final exam					**50**
F	The exam covers all contents related to the expected learning outcomes 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; S: Seminar*

11. Course details:

Week	Contents	CLOs
1	***Chapter 1. Overall wireless communication*** *(3/0/6)*	
	Teaching contents: *(3)* 1.1 Concepts 1.2 Diversity 1.3 OFDM 1.4 MIMO **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.1, G2, G3.
	Self-study contents: *(6)* 1.5 Space and time code 1.6 Orthogonal space and time 1.7 Half-duplex transmission	
2	***Chapter 2. Mobile communication systems*** *(3/0/6)*	
	Teaching contents: *(3)* 2.1 GSM mobile network **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.2, G4.1, G4.3, G5
	Self-study contents: *(6)* 2.2 GMSK modulation 2.3 Multi-access techniques 2.4 Channels in GSM	
3	***Chapter 2. Mobile communication systems (cont.)*** *(3/0/6)*	
	Teaching contents: *(3)* 2.5 3G WCDMA/UMTS mobile network **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.2, G4.1, G4.3, G5
	Self-study contents: *(6)* 2.6 Spread spectrum techniques 2.7 Hard hand over and its operation	

	2.8 Channels in 3G WCDMA/UMTS	
4	***Chapter 2. Mobile communication systems (cont.)*** *(3/0/6)*	
	Teaching contents: *(3)* 2.9 4G LTE mobile network **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.2, G4.1, G4.3, G5
	Self-study contents: *(6)* 2.10 WiMaX 2.11 Antenna techniques 2.12 Turbo and convolutional codes	
5	***Chapter 3:*** **Advanced solution in wireless communication** *(3/0/6)*	
	Teaching contents: *(3)* 3.1. Cognitive radio network **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.3, G2, G3, G4.3
	Self-study contents: *(6)* 3.2. Software-defined radio (SDR) 3.3. Right and miss detection probabilities 3.4. Lisenced spectrums	
6	***Chapter 3:*** **Advanced solution in wireless communication (cont.)** *(3/0/6)*	
	Teaching contents: *(3)* 5.4. Cooperative communication **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.3, G2, G3, G4.3
	Self-study contents: *(6)* 3.5. Combining methods 3.6. Relay selection methods. 3.7. Cooperative cognitive radio network	
7	***Chapter 3:*** **Advanced solution in wireless communication (cont.)** *(3/0/6)*	
	Teaching contents: *(3)* 3.8. Physical Layer Security in wireless network **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.3, G2, G3, G4.3
	Self-study contents: *(6)* 3.9. Artificial interference 3.10. Jammer selection 3.11. Randomize-and-forward technique 3.12. Cooperative network with physical layer security	
8	***Chapter 3:*** **Advanced solution in wireless communication (cont.)** *(3/0/6)*	
	Teaching contents: *(3)* 3.13. Energy Harvesting from wireless signal **Teaching methods**:	G1.3, G2, G3, G4.3

	+ Theoretical lectures + Questions and discussion **Self-study contents**: *(6)* 3.14. Ideal receiver for signal processing and energy harvesting 3.15. Energy harvesting model *3.16.* Cooperative network with energy-harvesting relay selection	
9	***Chapter 4: Technical trends for 5G network*** *(3/0/6)*	
	Teaching contents: *(3)* 4.1 Massive MIMO 4.2 Mmwave communication **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.4, G4.1, G4.3
	Self-study contents: *(6)* 4.3 Antennas used in Massive MIMO 4.4 MRC, ZF and MMSE receivers 4.5 Combination of Mmwave and Massive MIMO	
10	***Chapter 4: Technical trends for 5G network (cont.)*** *(3/0/6)*	
	Teaching contents: *(3)* 4.6 Full-duplex 4.7 Cloud-RAN **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.4, G4.1, G4.3
	Self-study contents: *(6)* 4.8 Types of NodeB configuration 4.9 Loop interference cancel methods	
11	***Chapter 4: Technical trends for 5G network (cont.)*** *(3/0/6)*	
	Teaching contents: *(3)* 4.10 Device-to-device (D2D) transmission 4.11 Ultra-dense Hetnets **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.4, G4.1, G4.3
	Self-study contents: *(6)* 4.12 Evaluate performance in D2D	
12	***Chapter 5: Viba transmission*** *(3/0/6)*	
	Teaching contents: *(3)* 5.1 Features of viba transmission 5.2 Viba devices 5.3 Design viba route **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.5, G4.2, G5
	Self-study contents: *(6)* 5.4 Learning viba devices in pratical	

	5.5 How to operate, maintain viba deivces	
13	***Chapter 6: Satellite communication*** *(3/0/6)*	
	Teaching contents: *(3)* 6.1 Overview of satellite communication system 6.2 Orbit of satellite and its parameters 6.3 Features of channel and route analyzation 6.4 Signal transmission in satellite communication channel **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.5, G4.2
	Self-study contents: *(6)* 6.5 Station 6.6 GPS system 6.7 VSAT system	
14	***Chapter 7: Some typical wireless networks*** *(3/0/6)*	
	Teaching contents: *(3)* 7.1 Wireless Lan 7.2 MANET (Mobile Ad-hoc Network) 7.3 VANET (Vehicular Ad-hoc Network) 7.4 Wireless sensitive network **Teaching methods**: + Theoretical lectures + Questions and discussion	G1.5, G4.2, G4.3
	Self-study contents: *(6)* 7.5 802.11 standards 7.6 Heterogeneous network	
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 2014

14. Approval level:

Dean	Department	Instructor

15. Syllabus updated process

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