



Course **090245138**

Broadband Wireless Communication Systems

King Mongkut's University of Technology North Bangkok
The Sirindhorn International Thai-German Graduate School of Engineering
Electrical and Computer Engineering Program

Section 1: General Information

1. Course code and course title

090245138 Broadband Wireless Communication Systems

2. Total credits

3 credits (2-2-5) (3-0-6) (3-0-9) (2-3-7)

3. Curriculum and course category:

Curriculum: *Master of Engineering in Electrical and Computer Engineering*

Course category: Required Courses

Core Course Specific Core Course
 Industrial Internship Master Thesis

Elective Courses

General Elective Specific Elective Other Elective

4. Course coordinator/ Instructors

Course Coordinator: Assoc. Prof. Dr. Soamsiri Chantaraskul

Instructor(s): Assoc. Prof. Dr. Chaiyod Pirak

5. Semester/ year of study

Semester 1 (Aug. to Dec.) Semester 2 (Jan. to May) Academic Year: **2021**

6. Pre-requisite (if any)

No Yes, please provide:

7. Co-requisites (if any)

No Yes, please provide:

8. Venue of study

Lecture Day/Time: Tuesday at 13.00-16.00

On-site: Lecture Room No.:...1103..... Floor:.....11th.....

TGGS, KMUTNB Faculty of Engineering, CU RWTH

On-line*: Teaching Media: Microsoft Teams Google Meet

Zoom Webex

Other (specify)

Remark: * During COVID-19, the teaching can be on-site and/or on-line according to TGGS Policy.



9. Information for quality assurance in education

This course shows evidence of:

- Development of implementation from previous practices, e.g. the improvement of class teaching, course content, content classification and methods used for learning assessment
- Involvement from professional bodies/ external agencies in instruction; thus Enhancing student academic and professional experiences
- Integration of research or creative activities with instruction; use of research-based learning management; knowledge management practices for learning improvement
- Integration of academic services and course implementation
- Combination of cultural heritage preservation efforts into instruction or student activities

10. Date of latest revision:

July 2020

Section 2: Course Description and Implementation

1. Course Description (*As written in the Official Approved Curriculum*)

Introduction to Digital Communications Discrete Channel Models. Principles of Orthogonal Frequency Division Multiplexing (OFDM). Multicarrier Transmission. Implementation by Fast Fourier Transform (FFT). Cyclic Prefix. Timing and Frequency Offset. Timing and Frequency Synchronization. Channel Estimation. Probability of Error Analysis. OFDM Systems Examples. Principles of Code Division Multiple Access (CDMA). CDMA Transmission Channel Models. Receiver Structures for Synchronous and Asynchronous Transmissions. Multicarrier CDMA. Wideband CDMA. CDMA2000. WiMax. UMTS-LTE, 4G, and 5G.

2. Number of hours per semester

Lecture	Practice	Self-study
45 hours/ semester (3 hours/week*)	30 hours (2 hours/week*)	75 hours/ semester (5 hours/week*)

Remark: * Based on 15 weeks of lecture

Course Category: Lecture Practice Laboratory

Course Evaluation: A-F S/U P



3. Number of hours per week for academic guidance to individual students

- 1. Giving academic advice (minimally number hour per week) during the office hour
2. Adopting information technology-based academic advising
3.

4. Course Learning Outcomes (CLOs): Students should be able to:

- CLO 1. Explain the theoretical concept of broadband wireless communication systems effectively, including:
CLO 2. Design the multicarrier wireless communication systems optimally, including the optimal subcarrier allocation, the cyclic prefix, and the optimal modulation scheme.
CLO 3. Design the CDMA systems optimally, including the spreading sequence generation, the digital modulation/demodulation, and the optimal receiver.
CLO 4. Analyze the performance of broadband wireless communication systems effectively by using both computer simulation and instruments.
CLO 5. Demonstrate the simulation results, experimental results, and assignments given in the class to the publics effectively.

Remark: 1. Guidelines according to Bloom's Taxonomy is available at https://courses.dcs.wisc.edu/design-teaching/PlanDesign_Fall2016/2-Online-Course-Design/2_Learning-Objectives-Alignment/6_objectives_blooms-taxonomy.html

- 2. For the master level course, CLOs should be "apply" and "analyze" or possibly to consider the doctoral CLOs "evaluate" and "create". "Remember" and "Understand" are for the undergraduate level courses, however, they can be implemented only at the beginning of the course.
3. CLOs can be defined as many as appropriated for the course.



Program: **ECE**
Degree Level: **Master**

Faculty/College: **TGGS**

5. The mapping between Expected Learning Outcomes (ELOs) from the curriculum and Course Learning Outcomes (CLOs)

Table 5.1 ELOs-CLOs Consistency *(for a subject-specific course/ a specific curriculum)*

ELOs/CLOs consistency	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
ELO1	✓				
ELO2				✓	
ELO3		✓	✓		
ELO4					
ELO5					
ELO6					
ELO7					✓
ELO8					
ELO9					
ELO10					

Remark: All ELOs and CLOs for the course (highlighted row) are as written in the Official Approved Curriculum.

Table 5.2 Mapping desirable characteristics of KMUTNB graduates and CLOs *(for non-specific courses designed for various curriculums)*

Consistency between desirable characteristics of KMUTNB Graduates- CLOs	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
1. Professional credentials with critical thinking skills				✓	
2. Integrity and social responsibility					✓
3. Innovative and technopreneur mindset		✓	✓		
4. Global Competence	✓				

Section 3: Student Improvement in relation to Course Learning Outcomes (CLOs)

Organizing learning to develop skills/ knowledge; evaluation of CLOs in accordance with the ones identified in Section 2.4



Course Learning Outcomes (CLOs)	Teaching Methods compliant with CLOs	Evaluation Methods compliant with CLOs
CLO 1	<ul style="list-style-type: none"> Lecture* Active learning** In-class exercises Individual and/or group assignment Additional reading assignments from research and/or literature journals 	<ul style="list-style-type: none"> Assignment evaluation Assessment of assigned exercises Exam****
CLO 2	<ul style="list-style-type: none"> Case studies, project-based learning In-class exercises Individual and/or group assignment Group discussions 	<ul style="list-style-type: none"> Assignment evaluation Assessment of assigned exercises Exam****
CLO 3	<ul style="list-style-type: none"> Case studies, project-based learning In-class exercises Individual and/or group assignment Group discussions 	<ul style="list-style-type: none"> Assignment evaluation Assessment of assigned exercises Exam****
CLO 4	<ul style="list-style-type: none"> Lecture on how to analyze the performance mathematically and numerically Demonstration on the use of computer software for simulations and/or writing the computer code for numerical simulations In-class exercises Group discussions on project updates Mentoring on the problem solving 	<ul style="list-style-type: none"> Assignment evaluation Assessment of assigned exercises Exam****
CLO 5	<ul style="list-style-type: none"> Case studies, project-based learning In-class exercises Additional reading assignments from research and/or literature journals Group discussions on project updates Project/Assignment presentation 	<ul style="list-style-type: none"> Assignment evaluation Assessment of assigned exercises

*Remark: * Lecture on the concept of the topic is introduced with basic or fundamental definitions, visualization and correlations. For the complicated equation, the derivation from the basic laws can be shown to students. So, the students do not memorize the equations but understand the basic concept and basic equation. The lecturer will introduce the advanced and new concepts, technologies, and findings to students from publications such as journals and websites and from the research and industrial experiences.*



*** Active learning by asking questions related to the topic in the lecture and encouraging the students to response to the questions. If the students cannot response with answers, then the lecturer will give some guidance until the students can response.*

**** Quiz in the closed-book format on the basic concepts and equations with simple problem solving to evaluate their learning. The solution will be given to students after grading, so they can identify their mistakes and weakness.*

***** Exam on the basic concepts and equations with simple problem solving in the closed-book format as a review, whereas the complicated/integrated problem solving will be worked in the open-book format.*

Section 4: Lesson Plan and Evaluation

1. Lesson Plan

Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
1	Introduction to broadband communication systems	CLO 1	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies 	Assoc. Prof. Dr.Chaiyod Pirak
2	General Principles of Orthogonal Frequency Division Multiplexing (OFDM)	CLO 1	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 1 	Assoc. Prof. Dr.Chaiyod Pirak
3	OFDM as Multicarrier Transmission	CLO 1	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises 	Assoc. Prof. Dr.Chaiyod Pirak
4	Implementation by FFT	CLO 1 CLO 2	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises 	Assoc. Prof. Dr.Chaiyod Pirak
5	OFDM with Guard Interval (Cyclic Prefix)	CLO 1 CLO 2	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 2 	Assoc. Prof. Dr.Chaiyod Pirak



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Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
6	Error Probability Performance Analysis	CLO 1	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 3 	Assoc. Prof. Dr.Chaiyod Pirak
7	OFDM Systems Examples	CLO 1 CLO 2	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 4 	Assoc. Prof. Dr.Chaiyod Pirak
8	Midterm Examination	CLO 4	3.0	<ul style="list-style-type: none"> Paper-based examination 	Assoc. Prof. Dr.Chaiyod Pirak
9	Synchronization, Channel Estimation, and Interleaving	CLO 1 CLO 2	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 5 	Assoc. Prof. Dr.Chaiyod Pirak
10	General Principles of Code Division Multiple Access (CDMA)	CLO 1	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies Project assignment 	Assoc. Prof. Dr.Chaiyod Pirak
11	CDMA Transmission Channel Models	CLO 1	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 6 	Assoc. Prof. Dr.Chaiyod Pirak



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Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
12	Spreading Sequences	CLO 1	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 7 	Assoc. Prof. Dr.Chaiyod Pirak
13	Receiver Structures for Synchronous and Asynchronous Wideband CDMA Transmissions: Part I	CLO 1 CLO 3	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 8 	Assoc. Prof. Dr.Chaiyod Pirak
14	Receiver Structures for Synchronous and Asynchronous Wideband CDMA Transmissions: Part II	CLO 1 CLO 3	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 9 	Assoc. Prof. Dr.Chaiyod Pirak
15	3G and 4G Mobile Communication Systems	CLO 1 CLO 3	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises Assignment No. 10 	Assoc. Prof. Dr.Chaiyod Pirak
16	5G Mobile Communication System	CLO 1 CLO 3	3.0	<ul style="list-style-type: none"> Lecture presentation slides Q&A Examples and Case Studies In-class exercises 	Assoc. Prof. Dr.Chaiyod Pirak
17	Project Presentation	CLO 1 CLO 2 CLO 3 CLO 4	3.0	<ul style="list-style-type: none"> Presentation of Students Video clip evaluation on the social media 	Assoc. Prof. Dr.Chaiyod Pirak



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Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
		CLO 5			
18	Final Examination	CLO 4	3.0	• Paper-based examination	Assoc. Prof. Dr.Chaiyod Pirak
		Total	54.0		

2. Evaluation Plan (in accordance with OBE 2 mapping framework)

Course Learning Outcomes (CLOs)	Evaluation Methods	Week of Evaluation	Percentage of Evaluation
CLO 1, 2, 3	10 Assignments	2, 5-7, 9, 11-15	15%
CLO 4	2 Exams	8, 18	70%
CLO 1, 2, 3, 4, 5	1 Project Assignment	10, 17	10%
	Participation	1-18	5%

Section 5 Teaching/Learning Resources

Textbooks and materials

Main Text: 1. Henrik Schulze and Christian Luders "Theory and Applications of OFDM and CDMA", John Wiley & Sons, 2005.

Section 6 Course Evaluation and Improvement

1. Course evaluation by students

The students will have an opportunity to evaluate the effectiveness of the course in a form of paper survey and group interview at the end of each semester. The results of survey and interview including the grading will be reviewed by the curriculum meeting to evaluate the course's effectiveness.

2. Strategies for assessing learning management

The students will have an opportunity to evaluate the teaching of the course in a form of paper survey and group interview at the end of each semester. The results of survey and interview including



the grading will be reviewed by the curriculum meeting to evaluate the teaching as well as returning to the lecturer for further improvement.

3. Improvement schemes of course implementation

The evaluation from the students including the grading will be submitted to the curriculum meeting for reviewing and brainstorming to improve teaching of each course. Comments and suggestions given by the curriculum meeting will be informed to the responsible lecturer of each course.

4. Verification of students' learning outcomes, referred to OBE 2 and 3

The grading of this course will be evaluated and reviewed by the Department meeting and the TGGS executive board meeting in order to verify its appropriateness before the final approval.

5. Course review and improvement plans

The results of the grading evaluation and student evaluation will be submitted to the curriculum meeting for reviewing and brainstorming to improve the effectiveness of the offered courses. Comments and suggestions will be informed to the responsible lecturer of each course.