國立中正大學 研究所 課程大綱

Graduate School Course - Course Syllabus
National Chung Cheng University

<table>
<tr><td>中文課程名稱
(Chinese Course Name)</td><td>無線通訊技術與安全</td><td>開課單位
(Offering Department/ Offering Unit)</td><td>資訊工程學系暨研究所
(Department of Computer Science and Information Engineering)

工學院前瞻製造系統碩博士學位學程
(Ph.D. Program in Advanced Manufacturing Systems)

工學院前瞻工程全英語碩士學位學程
(Master Program in Advanced Manufacturing Systems)

機械工程學系國際智慧製造碩士專班
(International Master Program in Smart Manufacturing)</td></tr>
<tr><td rowspan="3">英文課程名稱
(English Course Name)</td><td rowspan="3">Wireless Communication Technology and Security</td><td>課程代碼
(Course Code)</td><td>114_1_4105483_01
114_1_4458009_01
114_1_4465026_01
114_1_4616049_01</td></tr>
<tr><td>上課時間
(Time)</td><td>週一 第3節、第4 節、第5節
(Monday AM 09:10 - AM 12:00)</td></tr>
<tr><td>上課地點
(Location)</td><td>EA205資工系館二樓
(2nd Floor, Room 205 at College of Engineering (I))

校園地圖(Campus Map):
https://ccu-navigation.ccu.edu.tw/app/index.php</td></tr>
<tr><td rowspan="2">授課教師
(Instructor)</td><td rowspan="2">江宗韋
(Tsung-Wei Chiang)</td><td>學分數
(Credits)</td><td>3</td></tr>
<tr><td>授課語言
(Language)</td><td>全英文授課/無限修人數
EMI Course (Teaching in English)</td></tr>
<tr><td>必/選修
(Required/Selected)</td><td>☐ 必修
(Required)
☑ 選修
(Selected)</td><td>開課年級
(Level)</td><td>研究所，碩博合開，開放大三大四選修
(Graduate Course: open to both Master's and Ph.D. students, also available as an elective for junior and senior undergraduate students)</td></tr>
<tr><td>課程屬性/類別
(Course type)</td><td colspan="3">☐ 人文關懷課程 ☐ 競賽專題課程
☐ 問題導向課程. ☐ 專題導向課程
☐ 總整課程 ☐ 實作課程
☐ 實習 ☑ 其他(Others)</td></tr>
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先修科目或先備能力 (Prerequisites)	1. Fundamental knowledge of probability theory 2. Fundamental knowledge of linear algebra
課程概述 (Course Descriptions)	This course provides a comprehensive introduction of key coding technology utilized in physical layer signal processing within 5G New Radio (NR) mobile communications. It may also emphasize security and privacy methodologies pertinent to emerging 6G systems at the physical layer. Furthermore, the course integrates theoretical concepts with practical, link-level wireless communication principles critical for 5G NR implementations through hands-on coding activities and simulations. Aimed at graduate-level students, the curriculum bridges academic theories with industrial applications, preparing students to effectively understand, analyze, and tackle future challenges in advanced wireless communication technology.
學習目標 (Learning Objectives)	1. Understand the key coding technology essential to physical layer signal processing in 5G New Radio (NR) communications. 2. Gain hands-on experience by conducting simulations and practical coding exercises using Python or MATLAB, specifically focusing on channel coding techniques used in 5G NR. 3. Explore current and emerging research topics related to 6G systems, emphasizing physical-layer security and privacy challenges, along with potential technological innovations and solutions.
教科書 (Textbooks and References)	Textbook: 1. Self-prepared presentation slides and lecture handouts will be provided (contents of this course are from multiple sources). References: 1. Erik Dahlman, Stefan Parkvall, Johan Sköld, *5G/5G-Advanced: The Next Generation Wireless Access Technology.* 3rd Edition, Academic Press, 2024. 2. S. Lin and J. Li, *Fundamentals of Classical and Modern Error-Correcting Codes*. Cambridge, U.K.: Cambridge University Press, 2021. 3. 李大嵩、李明峻、詹士慶、吳昭沁, *第五代行動通訊系統 3GPP New Radio(NR): 原理與實務*. 全華圖書, 2021. 4. Ali Zaidi, Fredrik Athley, Jonas Medbo, Ulf Gustavsson, Giuseppe Durisi, Xiaoming Chen, *5G Physical Layer: Principles, Models and Technology Components.* Academic Press, 2018. 5. V.-L. Nguyen, P.-C. Lin, B.-C. Cheng, R.-H. Hwang, and Y.-D. Lin, "Security and privacy for 6G: A survey on prospective technologies and challenges," *IEEE Communications Surveys & Tutorials*, vol. 23, no. 6, pp. 2384 – 2428, Nov. – Dec. 2021. 6. 3GPP Specifications.

課程大綱(Course Syllabus)		概要分配時數(Number of Approximate Hours)	核心能力(Core Capabilities)
單元主題(Topic)	內容綱要(Content)	講授(Lecture)	
1. Introduction	✧ Introduction to the course	1	■A1 □A2 □A3 □A4 □A5 □A6 □A7 ■A8
2. Essential Mathematical Background	✧ Basic algebra and probability inequalities	2	■A1 □A2 □A3 □A4 □A5 □A6 □A7 ■A8
3. Basics of Information Theory	✧ Communication in the presence of noise ✧ Shannon’s theorem, channel coding gain	7	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
4. Wireless Channel Model for 5G NR	✧ 3D channel model and fading effects ✧ 3GPP TR 38.901	5	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
5. LDPC Codes: Basics	✧ Low-Density Parity-Check (LDPC) codes, Tanner graph, girth of a graph	6	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
6. LDPC Codes: Decoding Algorithms	✧ Decoding algorithms for LDPC (e.g., majority-logic, bit flipping, a posterior probability, and sum-product algorithms)	6	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
7. LDPC Codes: for 5G NR	✧ Quasi-Cyclic LDPC ✧ LDPC for 5G NR data (shared) channels	7	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
8. 5G NR Physical Layer Signal Processing	✧ Transport channel processing, downlink/uplink physical processing in 5G NR, rate matching, and HARQ ✧ 3GPP TS 38.212	6	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
9. Private and Secure Technology (I) (Optional)	✧ Introduction to research topics in privacy-preserving and secure wireless technologies for 6G	5	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
10. Private and Secure Technology (II) (Optional)	✧ Introduction to research topics in privacy-preserving and secure wireless technologies involving AI	5	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
教學要點概述 (Teaching Key Points Overview)			

教材編選 (Teaching Materials)	■自製簡報(Self-prepared presentation slides) ■課程講義(Lecture handouts) ■教學程式(Teaching scripts/programs)
教學方法 (Teaching Methods)	■投影片講述(Slide-based instruction) ■板書講述(Blackboard-based instruction)
評量工具 (Evaluation Tools)	■上課點名(Attendance) 20% ■隨堂作業(In-class assignments) 30% ■程式實作(Programming projects) 20% ■期末報告(Final report) 30%
教學資源 (Teaching Resources)	■課程網站(Course website) ■教材電子檔供下載(Digital materials for download) □實習網站(Lab website)
教師 相關訊息 (Instructor's Information)	全英文授課。 (This course will be taught in English.) 請學生尊重智慧財產權及使用正版教科書。 (Students should respect intellectual property rights and use authorized textbooks.)
教學相關配合 事項 (Course relative information)	Plagiarism is strictly prohibited for all homework and assignments, including code and reports. Any student found engaging in plagiarism will automatically fail the course.

課程目標與教育核心能力相關性
(Relationship between Course Objectives and Core Educational Competencies)

請勾選: ☑ A1 ☑ A2 ☑ A3 ☑ A4 ☐ A5 ☐ A6 ☐ A7 ☑ A8

A1	**具有資訊工程與科學領域之專業知識**(Competence in computer science and computer engineering.)
	為何有關(Why Relevant): The course content covers the fundamental coding knowledge applied for 5G NR mobile communications and related privacy and security introductions, aiming to cultivate students' professional knowledge from a systematic perspective in the field of information and communication.
	達成指標(Achievement Indicators): Grades are determined by assignments, practical programming tasks, and the final (project) report. Graduate students must achieve a score of over 70, and undergraduates must exceed 60 to pass.
	評量方法(Assessment Methods): Assessment Criteria for Assignments, Programming Projects, and the Final (Project) Report:

	• Level 5: Submission of 80% of assignments and an anticipated semester grade of 80 points or above, or a report grade of 80 points or above. • Level 4: Submission of 60% of assignments and an anticipated semester grade of 70 points or above, or a report grade of 70 points or above. • Level 3: Submission of 40% of assignments and an anticipated semester grade of 60 points or above, or a report grade of 60 points or above. • Level 2: Submission of 20% of assignments and an anticipated semester grade of 50 points or above, or a report grade of 50 points or above. • Level 1: No assignment submissions or an anticipated semester grade of less than 50 points, or a report grade of less than 50 points.
A2	**具有創新思考、問題解決、獨立研究之能力**(Be creative and be able to solve problems and to perform independent research.)
	為何有關(Why Relevant): Assignments integrate practical experience; students are required to write programming implementations to enhance their ability to independently solve practical and interesting problems. Assignments will also include reading academic literature and providing concrete summaries.
	達成指標(Achievement Indicators): Students are encouraged to participate in discussions and bravely attempt solutions, but must complete their assignments independently. Flaws or errors in assignments are entirely acceptable, as there may not always be an absolute correct answer. Plagiarism is strictly prohibited for all homework and assignments.
	評量方法(Assessment Methods): Same as the Assessment Criteria outlined in A1.
A3	**具有撰寫中英文專業論文及簡報之能力**(Demonstrate good written, oral, and communication skills, in both Chinese and English.)
	為何有關(Why Relevant): Students are required to complete the final project report in English, clearly articulating the motivation, logical reasoning, methodology, and outcomes.
	達成指標(Achievement Indicators): The final project report should be clear, easy to follow, logically sound, and systematically organized.
	評量方法(Assessment Methods): Same as the Assessment Criteria outlined in A1.
A4	**具策劃及執行專題研究之能力**(Be able to plan and execute projects.)
	為何有關(Why Relevant): Students will base their work on programming assignments to complete a final project report. The report should clearly present the motivation, methodology, results, and possible innovations.
	達成指標(Achievement Indicators): The final project report should be clear, easy to follow, logically sound, and systematically organized.
	評量方法(Assessment Methods): Same as the Assessment Criteria outlined in A1.
	具國際觀及科技前瞻視野(Have international view and vision of future technology.)
	為何有關(Why Relevant):

A8	Assignments will include tasks for students to read the latest academic articles and produce summaries. Students are required to learn about current knowledge of one of the key coding technology in 5G mobile communications as well as the potential developments in the future 6G system.
	達成指標(Achievement Indicators): Students can study international journals and conference papers, and are able to accurately summarize and analyze their contents.
	評量方法(Assessment Methods): Same as the Assessment Criteria outlined in A1.

教育目標
(Educational Objectives)

1.具獨立從事學術研究或產品創新研發之人才(To cultivate talent with the ability to conduct independent academic research or drive product innovation and development.)

2.具團隊合作精神及科技整合能力，並在團隊中扮演領導、規劃、管理之角色(To develop teamwork spirit and technological integration skills, enabling individuals to assume leadership, planning, and management roles within a team.)

3.具創新研發、自我挑戰與終身學習能力之人才(To nurture talent with innovative research capabilities, a drive for self-challenge, and a commitment to lifelong learning.)

4.具有學術倫理、工程倫理、國際觀之人才(To foster individuals with academic integrity, engineering ethics, and a global perspective.)

核心能力
(Core Competencies)

A1.具有資訊工程與科學領域之專業知識(Competence in computer science and computer engineering.)

A2.具有創新思考、問題解決、獨立研究之能力(Be creative and be able to solve problems and to perform independent research.)

A3.具有撰寫中英文專業論文及簡報之能力(Demonstrate good written, oral, and communication skills, in both Chinese and English.)

A4.具策劃及執行專題研究之能力(Be able to plan and execute projects.)

A5.具有溝通、協調、整合及進行跨領域團隊合作之能力(Have communication, coordination, integration skills and teamwork in multi-disciplinary settings.)

A6.具有終身學習與因應資訊科技快速變遷之能力(Recognize the need for, and have the ability to engage in independent and life-long learning.)

A7.認識並遵循學術與工程倫理(Understand and commit to academic and professional ethics.)

A8.具國際觀及科技前瞻視野(Have international view and vision of future technology.)