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>課程名稱(中文)
(Chinese Course Name)</td><td>圖信號處理</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
(Master of Science 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">課程名稱(英文)
(English Course Name)</td><td rowspan="3">Graph Signal Processing</td><td>課程代碼
(Course Code)</td><td>113_2_4105485_01
113_2_4457041_01
113_2_4616030_01</td></tr>
<tr><td>上課時間
(Time)</td><td>五E、五F (Friday E、Friday F)
(Friday 13:10-16:00)</td></tr>
<tr><td>上課地點
(Location)</td><td>EA104
(Room 104 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>
<tr><td>先修科目或先備能力
(Prerequisites)</td><td colspan="3">Basics of linear algebra or matrix theory</td></tr>
<tr><td>課程概述
(Course Descriptions)</td><td colspan="3">This course provides an in-depth exploration of mathematical tools and applications essential for analyzing signals or data processing on graphs. Graphs are versatile representations used across various fields, including physical networks (like the Internet, sensor networks, smart grids, neural networks, social</td></tr>
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	networks, and biological networks) and data structures (like image pixels or AI training datasets). This course blends theoretical foundations with practical applications, featuring hands-on exercises in graph signal processing (GSP). As a graduate-level course, it also delves into the latest research trends in GSP development. Students will develop a robust theoretical understanding necessary for network analysis and will address relevant security and/or privacy topics within advanced GSP technology.
學習目標 (Learning Objectives)	1. Develop the mathematical skills, tools, and insights that allow students to think or solve problems in terms of the processing of signals on graphs 2. Conduct numerical experiments through hands-on coding in Python, MATLAB (or C/C++) for toy examples or mini projects. 3. Understand research topics related to networks and AI, including the exploration of privacy and security issues in research.
教科書 (Textbooks and References)	Textbooks: Antonio Ortega, *Introduction to Graph Signal Processing*, Cambridge University Press, 2022. References: L. Stanković, M. Daković, and E. Sejdić, *Introduction to Graph Signal Processing*, Springer, 2019.

課程大綱(Course Syllabus)		分配時數 (Number of Hours)	核心能力 (Core Capabilities)
單元主題(Topic)	內容綱要(Content)	講授 (Lecture)	
1. Introduction to The Course and Overview	Introduction to signal processing on graphs and analyzing data associated with graphs	4	■A1 □A2 □A3 □A4 □A5 □A6 □A7 ■A8
2. Processing on Node (Vertex) Domain	Processing of signals or data on graph in the node (vertex) domain, based on information from its neighbors, locality, representations of graphs, graph filters, and graph operators	8	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
3. Processing on Frequency (Spectral) Domain	Processing of signals or data on graph in the spectral (frequency) domain, frequency representations for graph signals, and graph Fourier transformation	8	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
4. Graph Signal Sampling	Graph signal models, constrains on signal acquisition, signal reconstruction, and sampling optimization	8	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8

5. Graph Signal Representations	Graph signal representations in both node and frequency domains, localization, and uncertainty principles	8	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
6. Graph Selection and Graph Learning	Graph approximation, constructing graphs from attributes, and learning graphs from signals	6	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
7. Applications (I): General Topics (Provisional)	Physical networks, social networks, sensor networks, image and video processing, and machine learning	6	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
8. Applications (II): Topics of Privacy and Security (Provisional)	Introduction to research topics of graph signal processing for privacy/security-preserving technology	6	■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) 10% ■隨堂作業(In-class assignments) 30% ■程式實作(Programming projects) 30% ■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	
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 material provides a theoretical understanding of signal and data processing on networks (graphs), while also exploring related privacy and security research topics. It aims to enhance students' analytical skills from a mathematical perspective within the fields of information networking and network science.
	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.
A8	**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): Assignments will include tasks for students to read the latest academic articles and produce summaries. Students are required to learn about the emerging field of graph signal processing and its potential applications in modern networking technology and network science.
	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.)