中正大學 資訊工程研究所 課程大綱

Graduate School Course - Course Syllabus
Department of Computer Science and Information Engineering
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
(Department)</td><td>資訊工程學系暨研究所
(Department of Computer Science and Information Engineering)

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">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>114_2_4105485_01
114_2_4465052_01
114_2_4616030_01</td></tr>
<tr><td>上課時間
(Time)</td><td>週五E節、F節
13:14 ~ 16:00
(Friday 13:14 ~ 16:00)</td></tr>
<tr><td>上課地點
(Location)</td><td>EA104資工系館一樓
(1st Floor, 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 colspan="2">☐ 必修
(Required)
☑ 選修
(Selected)</td><td>開課年級
(Level)
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 (Humanistic Care Courses)
☐競賽專題課程 (Competition-Based Project Courses)
☐問題導向課程 (Problem-Based Learning Courses / PBL)
☐專題導向課程 (Project-Based Learning Courses / PjBL)
☐總整課程 (Capstone Courses)
☐實作課程 (Hands-on Courses / Practical Courses)
☐實習 (Internship / Practicum)
☑其他</td></tr>
<tr><td>先修科目或先備能力
(Prerequisites)</td><td colspan="3">Basics of linear algebra</td></tr>
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課程概述 (Course Descriptions)	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 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 Reference)	Reference: 1. Antonio Ortega, Introduction to Graph Signal Processing, Cambridge University Press, 2022. 2. Albert-L*ászló* Barab*á*si, Network Science, Cambridge University Press, 2016. 3. Mark E. J. Newman, Networks, 2nd ed., Oxford University Press, 2018.

課程大綱(Course Syllabus)		週次(堂次) (Week/Session)	核心能力 (Core Capabilities)
單元 主題(Topic)	內容綱要(Content)	講授(Lecture)	
Topic 1: Introduction to Epidemics on Networks; Course Overview	Introduction to course structure and problem-based learning workflow; basic concepts of epidemic spreading on networks; group formation, selection of networks and spreading scenarios, and formulation of initial research questions	Week 1	■A1 □A2 □A3 □A4 □A5 □A6 □A7 ■A8
Topic 1: SIS/SIR Models and Fundamental Spreading Mechanisms	Discussion of how infection and recovery probabilities are defined on graph structures; groups revise research questions and modeling assumptions	Week 2	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 1: Epidemic Simulations on Real-World Networks	Construction of networks using Python and implementation of epidemic models; observation of epidemic dynamics under different parameter settings; groups summarize preliminary results	Week 3	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 1: Epidemic Analysis and Group Presentations	Group presentations of simulation results, explaining the relationship between network structure and spreading speed; reflection on model limitations and possible improvements	Week 4	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8

Topic 2: Community Structure and Modularity	Introduction to the concept of community structure and the modularity measure; discussion of example networks to explore what constitutes a "community"	Week 5	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 2: Community Detection Algorithms (e.g., Girvan – Newman, Louvain)	Each group selects one or two community detection methods, implements them on their own datasets, and documents the results	Week 6	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 2: Analysis and Visualization of Community Detection Results	Groups compare community structures obtained from different algorithms and parameter settings; visualization of results and linkage to the original research questions	Week 7	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 2: Group Presentations on Community Analysis	Group presentations of community detection results and interpretations, highlighting the impact of community structure on network functions or behaviors	Week 8	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 3: Introduction to Network Search and Shortest Paths	Introduction to network search problems and shortest path concepts; groups propose search scenarios of interest (e.g., information search, routing)	Week 9	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 3: Search Strategies and Algorithm Design	Groups design different search strategies (e.g., greedy search, random walk) and implement them on selected networks	Week 10	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 3: Performance Analysis and Comparison of Search Methods	Analysis of search success rate, number of steps, and cost; discussion of how network structures or algorithms can be improved	Week 11	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 3: Group Presentations on Search Projects	Groups present experimental designs and results, evaluating whether the original research questions have been addressed	Week 12	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 4: Introduction to Graph Signal Processing (GSP) Projects	Overview of basic concepts in graph signal processing; definition of node signals on networks; groups determine final project topics and data sources	Week 13	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 4: Project Design and Selection of GSP Methods	Design of graph models and node signals; selection of graph signal processing or network analysis techniques (e.g., graph filtering, spectral clustering); completion of project proposal	Week 14	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8

Topic 4: Project Implementation and Midterm Feedback	Groups implement projects according to proposals and collect preliminary results; in-class discussion and instructor feedback	Week 15	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 4: Presentation of Intermediate Project Outcomes	Groups present intermediate results and identify experiments or analyses requiring further refinement	Week 16	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 5: Final Project Presentations and Demonstrations (I)	Comprehensive group presentations covering research questions, graph construction, GSP/ network analysis workflows, and conclusions	Week 17	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8
Topic 5: Final Project Presentations and Demonstrations (II) and Course Reflection	Group presentations; whole-class reflection and discussion on the problem-based learning process and learning outcomes related to graph signal processing	Week 18	■A1 ■A2 ■A3 ■A4 □A5 □A6 □A7 ■A8

備註(Notes)：
本課程大綱為目前之規劃內容，可能因國定假日、不可預期之停課、演習或其他特殊情況而調整；相關異動將另行公告，並以實際上課公告為準。授課教師將視情況提供適切之課程安排與教學內容。(This syllabus reflects the current course plan and may be adjusted due to national holidays, unforeseen class suspensions, drills, or other special circumstances. Any changes will be announced through official course channels. The instructor will make appropriate adjustments to course arrangements and instructional content as needed.)

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) ■小組討論(Group discussion) ■學生口頭報告(Student oral presentations) ■問題導向學習(Problem-Based Learning) ■其他(Others)
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)	EMI課程，全英文授課。 English-Medium Instruction (EMI); taught entirely 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： 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： 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 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： 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： 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： 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： Students are required to complete the final project report in English, clearly articulating the motivation, logical reasoning, methodology, and outcomes.
	達成指標： The final project report should be clear, easy to follow, logically sound, and systematically organized.
	評量方法： 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： 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： The final project report should be clear, easy to follow, logically sound, and systematically organized.
	評量方法： 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： 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： Students can study international journals and conference papers, and are able to accurately summarize and analyze their contents.
	評量方法： Same as the Assessment Criteria outlined in A1.

教育目標
1.具獨立從事學術研究或產品創新研發之人才
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
3.具創新研發、自我挑戰與終身學習能力之人才
4.具有學術倫理、工程倫理、國際觀之人才

核心能力
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.)