



教學計劃表 Syllabus

課程名稱(中文) Course Name in Chinese	分散式系統		學年/學期 Academic Year/Semester	115/1	
課程名稱(英文) Course Name in English	Distributed Systems				
科目代碼 Course Code	CSIEM0140	系級 Department & Year	碩士	開課單位 Course-Offering Department	資訊工程學系
修別 Type	選修 Elective	學分數/時間 Credit(s)/Hour(s)	3.0/3.0		
授課教師 Instructor	/吳秀陽				
先修課程 Prerequisite					
課程描述 Course Description					
<p>A distributed system is a collection of independent computers and related software that appears to its users as a single coherent system. In the Internet/Web/Mobile/Cloud/IoT era, almost all our daily used net-related applications or services are provided by distributed systems. The latest AI LLMs such as ChapGPT and DeepSeek are trained on large scale distributed systems. It is one of the central knowledge that all computer science students must possess in order to be competitive in the fast changing world. The purpose of this course is to investigate the theory and practice underlying the design, construction and operation of distributed systems. We will discuss the fundamental principles such as distributed processes, addressing and naming, communication mechanisms, synchronization and coordination, replication and consistency, fault tolerance, distributed algorithms, transactions and concurrency control, security, mobile/pervasive computing, cloud services, big data processing, Internet of Things(IoT), etc.. A special topic is selected for each semester. Distributed systems for AI & ML is the special topic of this semester. We will introduce the basic architectures and operation of LLMs. Distributed training and serving of LLMs. Modern AI data centers architectures and operation. If time permits, we will also discuss Distributed Quantum Computing (DQC) on a recent breakthrough that may have a profound impact on the entire world of computing.</p> <p>In addition to the lecture part of the course, students are also required to conduct an independent study on selected topics and present papers in class. Students will also learn how to build distributed applications through assignments and term project. More details on the lecture notes.</p>					
課程目標 Course Objectives					
<p>A distributed system is a collection of independent computers and related software that appears to its users as a single coherent system. In the Internet/Web/Mobile/Cloud/IoT era, almost all popular network-based applications or services can be considered as provided by distributed systems. It is one of the central knowledge that all computer science students must possess in order to be competitive in the fast changing world. The purposes of this course are to investigate the theories and practices underlying the design, construction and operation of distributed systems. In the lecture part, we will discuss fundamental principles such as distributed processes, addressing and naming, communication mechanisms, synchronization and coordination, replication and consistency, fault tolerance, distributed algorithms, transactions and concurrency control, security, mobile/pervasive computing, cloud services, big data processing, Internet of Things(IoT), etc.. Students are also required to conduct an independent study on selected topics and present papers in class. To gain hands-on experience on the design and construction of distributed system, students will also learn how to use proper tools for building distributed applications through lab, assignments and term project.</p>					

系專業能力 Basic Learning Outcomes		課程目標與系專業能力相關性 Correlation between Course Objectives and Dept.'s Education Objectives
A	統合資工知識技術之能力Ability to integrate knowledge and technologies of computer science and information engineering.	●
B	設計技術理論驗證實驗之能力Ability to design and conduct science experiments and to validate hypotheses.	●
C	資訊軟硬體設計開發之能力Ability to design and develop computer software and hardware.	●
D	團隊專案開發之能力Ability to design and develop team projects.	●
E	批判性思考與創新研發之能力。Ability of analytical thinking, creative research planning, and innovative development.	●

圖示說明Illustration：● 高度相關 Highly correlated ○ 中度相關 Moderately correlated

授課進度表 Teaching Schedule & Content

週次Week	內容 Subject/Topics	備註Remarks
1	Course introduction, course information, requirement, syllabus, AI policy	
2	Introduction: Introduction to distributed systems Definition and characteristics Networking and internetworking essentials Resource sharing, scalability & transparency Design goals Classification of distributed systems Examples of modern distributed systems Historical evolution Current and future trends	
3	Architectures and Middlewares: Architectural styles System models and architectures Middlewares Layered-system architectures Client-server architectures Multi-tier architectures Edge and cloud computing architectures Microservices and service architectures Self-management	
4	Distributed Processes I: Processes, threads and multithreading (Python threads) Clients and servers Operating system support	
5	Distributed Processes II: Virtualization Virtual machines and containers Code mobility and agents Microservices	
6	Communication I: Interprocess communication models Sockets and REST Remote invocation (RPC/RMI)	
7	Communication II: Message-oriented communication Message queues Multicast and group communication Streaming systems	

8	Addressing and Name Services: Fundamentals and naming systems Flat vs. structured naming Attribute-based naming Directory services DNS and service discovery	
9	No Midterm Exam, study topics and schedule arrangement Time, Synchronization & Coordination I: Time and clock synchronization Physical vs logical clocks Lamport clocks and vector clocks Causal ordering Distributed synchronization	
10	Time, Synchronization & Coordination II: Global state and snapshot Mutual exclusion Location systems Gossip-based coordination Swarm intelligence	
11	Distributed Algorithms & Computation: Election Consensus Distributed event processing Distributed graph algorithms MapReduce BSP(Bulk Synchronous Parallel)	
12	Distributed Storage & Data Management: Distributed storage File service architecture Network File System Mobile File System Distributed database systems New storage technologies **	
13	Consistency and Replication: Consistency and replication models Replica management Consistency protocols CAP theorem Eventual consistency Quorum systems Fault Tolerance:** Failure Models and Process Resilience Reliable Communication Security:** Security Models Access Control Security Management	
14	Special topics: Distributed systems for AI & ML I Introduction to modern AI & ML Neural networks and transformer architecture Large Language Models (LLMs) Attention mechanisms Training vs inference Distributed training: Data, model and pipeline parallelism GPU clusters Distributed gradient synchronization NCCL and collective communication	

15	Sepical topics: Distributed systems for AI & ML II Distributed inference systems Model serving architectures KV cache Batch scheduling GPU utilization vLLM and serving frameworks Moderan AI Data Centers: Hyperscale datacenter architecture GPU/TPU clusters High-speed networking RDMA and InfiniBand Storage systems for AI Power and cooling considerations	
16	Student presentation	
17	期末考試週 Final Exam	

彈性 教學 規劃 Flexible Teaching Plan	<p>請勾選(至少需勾選1 個項目): Please tick the box(es). (At least one item is required.):</p> <p><input checked="" type="checkbox"/> 問題討論 Problem-based Discussion</p> <p><input type="checkbox"/> 翻轉教學 Flipped Classroom</p> <p><input checked="" type="checkbox"/> 展演實作 Performance / Practical Presentation</p> <p><input type="checkbox"/> 校外參訪 Off-campus Visit</p> <p><input type="checkbox"/> 講座活動 Lecture / Seminar</p> <p><input type="checkbox"/> 線上作業 Online Assignments</p> <p><input type="checkbox"/> 自主學習 Self-directed Learning</p> <p><input type="checkbox"/> 課業輔導 Academic Support</p> <p><input type="checkbox"/> 實驗操作 Experiment Operation</p> <p><input type="checkbox"/> 遠距教學(同步) Distance Learning (Synchronous)</p> <p><input type="checkbox"/> 遠距教學(非同步) Distance Learning (Asynchronous)</p> <p><input type="checkbox"/> 其他(請填寫) Others (Please specify.):</p> <p>備註: 本校學期週數自115 學年度起調整為17 週, 為符合1學分18 小時之原則, 請教師規劃安排彈性教學。 Note: From the 115th academic year, the semester will be 17 weeks. Please include flexible teaching activities to meet the required 18 hours per credit.</p>
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教學策略 Teaching Strategies

- 課堂講授 Lecture 分組討論 Group Discussion 參觀實習 Field Trip
- 其他 Miscellaneous: Independent study and presentation

教學創新自評 Teaching Self-Evaluation

創新教學 (Innovative Teaching)

- 問題導向學習 (PBL) 團體合作學習 (TBL) 解決導向學習 (SBL)
- 翻轉教室 Flipped Classroom 磨課師 Moocs

社會責任 (Social Responsibility)

- 在地實踐 Community Practice 產學合作 Industry-Academia Cooperation

跨域合作 (Transdisciplinary Projects)

- 跨界教學 Transdisciplinary Teaching 跨院系教學 Inter-collegiate Teaching

- 業師合授 Courses Co-taught with Industry Practitioners

其它 other:

學期成績計算及多元評量方式 Grading & Assessments

配分項目 Items	配分比例 Percentage	多元評量方式 Assessments							
		測驗 會考	實作 觀察	口頭 發表	專題 研究	創作 展演	卷宗 評量	證照 檢定	其他
平時成績(含出缺席) General Performance (Attendance Record)	20%			✓	✓				Independent study and presentation
期中考成績 Midterm Exam	0%								
期末考成績 Final Exam	20%	✓							
作業成績 Homework and/or Assignments	40%		✓						
其他 Miscellaneous (Term Project)	20%		✓		✓	✓			

評量方式補充說明

Grading & Assessments Supplemental instructions

教科書與參考書目 (書名、作者、書局、代理商、說明)

Textbook & Other References (Title, Author, Publisher, Agents, Remarks, etc.)

Textbook: (Recommended but not required)

Maarten Van Steen and Andrew S. Tanenbaum. Distributed Systems, 4.03th Edition. 2025.

(<https://www.distributed-systems.net/index.php/books/ds4/>)

Martin Kleppmann and Chris Riccomini. Designing Data-Intensive Applications, 2nd Edition. 2026.

(<https://www.oreilly.com/library/view/designing-data-intensive-applications/9781098119058/>)

References:

Unmesh Joshi. Patterns of Distributed Systems. Addison-Wesley, 2024.

Roberto Vitillo. Understanding Distributed Systems: What every developer should know about large distributed applications, 2nd Edition. 2022. (<https://understandingdistributed.systems/>)

課程教材網址(含線上教學資訊, 教師個人網址請列位於本校內之網址)

Teaching Aids & Teacher's Website(Including online teaching information.

Personal website can be listed here.)

Web Page: on e-Learning

其他補充說明 (Supplemental instructions)

Must do the term project to pass the class!!