Lingnan University

Course Syllabus

Course Title	:	Capstone 2 - Design Challenge
Course Code	:	CDS4106
Recommended Study Year	:	Year 4
No. of Credits	:	3
Mode of Tuition	:	Sectional Approach
Class Contact Hours	:	3 hours per week
Category	:	Capstone Course
Discipline	:	Nil
Prerequisite(s)	:	CDS4105 Capstone 1 - Innovation, Technology and Design
Co-requisite(s)	:	Nil
Exclusion(s)	:	Nil
Exemption Requirement(s)	:	Nil

Brief Course Description:

Capstone projects provide students with an opportunity to synthesize and apply knowledge gained throughout their academic journey. This course centres on the design, implementation, and optimisation of a product-oriented system under real-world constraints. Students undertake a capstone project to conceive, build, and demonstrate an integrated solution that combines software, hardware, data processing, and user interaction. Emphasis is placed on system integration, performance optimisation, and the professional delivery of a functional prototype, reflecting the increased technical complexity and product maturity expected at the final stage of undergraduate study.

Aims:

This course aims to:

1. Provide students with a product-oriented capstone experience focused on the delivery of a complete, integrated system rather than a conceptual design.
2. Engage students in system-level design and development through the integration of software, hardware, data processing, and user interaction.
3. Guide students in translating design concepts into functional and usable product prototypes through iterative implementation and refinement.
4. Expose students to professional product development considerations, including usability, reliability, scalability, sustainability, and ethical responsibility.

5. Foster professional practice in individual and collaborative product development, technical communication, and formal system demonstration.
6. Prepare students for independent delivery of integrated design solutions that meet real-world requirements and professional standards.

Learning Outcomes (LOs)

Upon successful completion of this course, students will be able to:

1. Design and implement a complete, product-oriented system by integrating software, hardware, data processing, and user interaction components. (PILO2, PILO5)
2. Apply system-level design principles to develop coherent software–hardware architectures that support functional, reliable, and usable products. (PILO1, PILO2)
3. Develop and refine functional product prototypes through iterative implementation, testing, and evaluation. (PILO5)
4. Integrate sensing, embedded, or physical components with software systems using appropriate interfaces, communication mechanisms, and data pipelines. (PILO2, PILO4)
5. Conduct verification and validation activities to evaluate system performance and product-level qualities, including usability, reliability, scalability, sustainability, and ethical responsibility, within real-world contexts. (PILO3, PILO7)
6. Demonstrate effective project management, communication, and collaboration practices, and deliver integrated design solutions that meet professional standards. (PILO6, PILO8)

Indicative Contents:

Design Challenge Definition and Project Planning

Formulation of product-oriented design challenges, including definition of system objectives, requirements, constraints, and performance criteria.

System Architecture and Integration Design

System-level architectural design for integrated software–hardware products, including system decomposition, interface definition, and data flow organisation.

Software and Hardware Implementation

Implementation and integration of software modules with sensing, embedded, or physical components to realise functional system prototypes.

System Testing and Validation

Testing, verification, and validation of integrated systems to assess functionality, performance, and usability against defined objectives.

Performance Optimisation and Iterative Refinement

Performance analysis and optimisation of software–hardware systems through profiling, tuning, and iterative refinement.

Product Delivery and Professional Demonstration

Preparation of technical documentation and professional presentation of a complete product-level system through live demonstration.

Teaching Methods:

This course is delivered through a project-based and studio-oriented approach that supports progressive system development. Teaching activities include supervised project work, structured studio sessions, and scheduled design checkpoints that guide students from achieving system design maturity to implementing and refining integrated systems. Formal presentations and live demonstrations are incorporated to enable students to communicate, justify, and reflect on their design and implementation outcomes within a professional context.

Measurement of Learning Outcomes:

Assessment / **LOs**	Class Attendance and Participation	System Design Demonstration	Integrated System Prototype	Final Presentation and Technical Report
	(10%)	(20%)	(30%)	(40%)
LO1		✓	✓	✓
LO2		✓		
LO3			✓	✓
LO4			✓	
LO5			✓	✓
LO6	✓			✓

1. Class Attendance and Participation assess students' professional engagement, contribution to design discussions, and appropriate collaboration or independent working practices throughout the capstone project. (LO6)

2. System Design Demonstration evaluates the coherence and appropriateness of the proposed system architecture, the clarity of software–hardware responsibilities, and the feasibility and justification of the overall system integration strategy. (LO1, LO2)
3. Integrated System Prototype assesses the extent to which students have successfully realised their proposed system through the implementation of core functionalities and the effective integration of software and hardware components, demonstrating that the system is operational, stable, and capable of functioning as a complete prototype. (LO1, LO3, LO4, LO5)
4. Final Presentation and Technical Report evaluate students' ability to professionally communicate and justify their completed system, including the application of systematic testing and verification strategies, validation of system performance against design objectives, and evidence of performance analysis and optimisation conducted during the development process. (LO1, LO3, LO5, LO6)

Assessment:

Class Attendance and Participation	10%
System Design Demonstration	20%
Integrated System Prototype	30%
Final Presentation and Technical Report	40%
Total	100%

Required/Essential Readings:

1. Ulrich, K. T., & ProQuest (Firm). (2020). Product design and development (Seventh edition). McGraw-Hill Education.
2. Wasson, C. S. (2015). System engineering analysis, design, and development: Concepts, principles, and practices (2nd ed.). Wiley.
3. Blanchard, B. S., & Fabrycky, W. J. (2011). Systems engineering and analysis (5th ed.). Pearson Education.

Recommended/Supplementary Readings:

1. Norman, D. A., & EBSCOhost. (2013). The design of everyday things (Revised and expanded edition). Basic Books.
2. Tidwell, J., Brewer, C., & Valencia, A. (2020). Designing interfaces: Patterns for effective interaction design (3rd ed.). O'Reilly Media.

3. Thomas, D., & Hunt, A. (2019). The pragmatic programmer: Your journey to mastery (20th anniversary ed.). Addison-Wesley Professional.
4. Cohn, M. (2004). User stories applied : for agile software development. Addison-Wesley.
5. Myers, G. J., Sandler, C., & Badgett, T. (2012). The art of software testing (3rd ed.). John Wiley & Sons.
6. Ammann, P., & Offutt, J. (2016). Introduction to software testing (2nd ed.). Cambridge University Press.
7. Hayes, T. C., Abrams, D., & Horowitz, P. (2025). Learning the art of electronics: A hands-on lab course (2nd ed.). Cambridge University Press.

Important Notes:

(1) Students are expected to spend a total of 9 hours (i.e. 3 hours of class contact and 6 hours of personal study) per week to achieve the course learning outcomes.
(2) Students shall be aware of the University regulations about dishonest practice in course work, tests and examinations, and the possible consequences as stipulated in the Regulations Governing University Examinations and Course Work. In particular, plagiarism, being a kind of dishonest practice, is "the presentation of another person's work without proper acknowledgement of the source, including exact phrases, or summarised ideas, or even footnotes/citations, whether protected by copyright or not, as the student's own work". Students are required to strictly follow university regulations governing academic integrity and honesty.
(3) Students are required to submit writing assignment(s) using Turnitin.
(4) To enhance students' understanding of plagiarism, a mini-course "Online Tutorial on Plagiarism Awareness" is available on http://pla.ln.edu.hk/.
(5) Students must adhere to the University's guidelines and practices when using Generative Artificial Intelligence (GAI) tools. The official documents "Guidelines for Using GAI Tools at Lingnan University" and "Best Practices for Ethical and Responsible Use of GAI Tools in Course Assessments" can be found here: https://www.ln.edu.hk/tlc/generative-artificial-intelligence/gai-guidelines-best-practices.

Lingnan University

Course Rubrics

Rubric for Attendance and Participation (10%)

Criterion	Excellent (90-100)	Good (70-89)	Pass (50-69)	Fail (0-49)
Class Attendance (50%)	Attends over 90% of all scheduled classes, including lectures and other sessions.	Attends at least 70% but less than 90% of all scheduled classes.	Attends at least 50% but less than 70% of all scheduled classes.	Attends less than 50% of all scheduled classes.
Class Participation (50%)	Actively and consistently participates in class activities, discussions, and in-class exercises; demonstrates strong engagement, preparedness, and constructive contribution.	Participates regularly in class activities and discussions; demonstrates adequate preparation and engagement.	Participates occasionally in class activities with limited engagement or preparation.	Rarely or never participates in class activities; shows minimal engagement or preparation.

Rubric for System Design Demonstration (20%)

Criterion	Excellent (80-100)	Good (65-79)	Pass (50-64)	Fail (0-49)
Design Rationality and Requirement Alignment (30%)	Presents a system design that is clearly appropriate and well aligned with defined objectives, requirements, and constraints. Key design decisions are purposeful and logically justified, demonstrating strong alignment between design choices and system needs.	Presents a generally appropriate system design aligned with most objectives and requirements, though some design decisions lack full justification or show minor misalignment with constraints.	Presents a basic system design that addresses core objectives, but alignment with requirements or constraints is weak, incomplete, or insufficiently justified.	Presents a system design that is poorly aligned with objectives or constraints, indicating fundamental misunderstandings or inappropriate design choices.
Design Completeness and System Coherence (40%)	Defines a complete and coherent system design, with all essential components clearly identified. System boundaries, module responsibilities, and interactions are logically	Defines a mostly complete system design with clear major components and relationships, though some elements or interactions may be	Defines a partially complete system design, with missing components, unclear boundaries, or inconsistencies that limit overall system coherence.	Fails to define a complete or coherent system design, with major gaps, contradictions, or lack of system-level structure.

	structured and internally consistent, demonstrating holistic system-level thinking.	under-specified or weakly articulated.		
Technical Feasibility and Implementation Readiness (30%)	Demonstrates a realistic and well-considered technical direction that is feasible within the project scope and constraints. Key technical challenges and risks are identified, with credible strategies or alternatives articulated to support implementation readiness.	Demonstrates a generally feasible technical direction, though some challenges, risks, or implementation considerations lack sufficient analysis or mitigation planning.	Proposes a technical direction that appears partially feasible but shows limited awareness of implementation challenges, risks, or practical constraints.	Proposes a technical direction that is unrealistic, infeasible, or incompatible with the project scope, constraints, or available resources.

Rubric for Integrated System Prototype (30%)

Criterion	Excellent (80-100)	Good (65-79)	Pass (50-64)	Fail (0-49)
Functional System Implementation (30%)	Core system functionalities are fully implemented and operate as a complete, integrated system. The prototype is runnable, demonstrable, and consistently performs its intended functions in alignment with the proposed system objectives.	Most core functionalities are implemented and operational, though minor features are incomplete or exhibit limited instability. Overall system functionality remains largely intact.	Basic functionalities are implemented, but important features are missing, partially implemented, or unstable, limiting overall system operation.	Core functionalities are largely unimplemented or non-functional. The system fails to operate as an integrated prototype.
Software–Hardware Integration Quality (25%)	Software and hardware components are successfully integrated and operate cohesively. Interfaces, communication mechanisms, and data flows function reliably, enabling coordinated system behaviour during operation and demonstration.	Software–hardware integration is generally effective, though minor issues in communication, synchronisation, or data handling are present and partially resolved.	Software and hardware components are only partially integrated, with noticeable issues that affect coordination, stability, or usability.	Software and hardware components fail to integrate effectively, resulting in fragmented, unreliable, or non-functional system behaviour.

System Performance and Reliability (25%)	The system demonstrates stable operation with appropriate performance for its intended use. Evidence of performance evaluation or reliability testing is provided, showing awareness of efficiency, responsiveness, robustness, or accuracy considerations.	System performance is generally acceptable, though performance evaluation is limited or minor reliability issues remain unresolved.	System performance is inconsistent or weak, with minimal consideration of reliability or performance assessment.	System performance is poor or unstable, with no evidence of performance evaluation or reliability consideration.
Verification, Validation, and Iterative Refinement (20%)	System functionality is systematically verified and validated against defined objectives. Testing outcomes are clearly used to guide iterative refinements and improvements to the integrated system.	Verification and validation activities are conducted at a basic level, though testing coverage or use of results for refinement is limited.	Minimal verification or validation is evident, with weak linkage between testing outcomes and system improvement.	No meaningful verification or validation activities are conducted, and system development shows no evidence of iterative refinement.

Rubric for Final Presentation and Technical Report (40%)

1. **Final Presentation Component (15%)**

Criterion	Excellent (80-100)	Good (65-79)	Pass (50-64)	Fail (0-49)
Presentation Organization and Delivery (80%)	Presentation is well-structured, coherent, and professionally delivered. The system, its functionality, and key outcomes are communicated clearly and confidently within the allotted time, demonstrating strong understanding of the completed project.	Presentation is generally clear and understandable, though organization, flow, or delivery may lack consistency or professional polish.	Presentation conveys basic information about the project but lacks clear structure, fluency, or confident delivery.	Presentation is unclear, poorly organized, or incomplete, failing to communicate the project effectively.
Engagement and Responsiveness in Discussion (20%)	Responds to questions accurately and confidently, demonstrating thoughtful engagement with the technical and design aspects of the system and clear ownership of the project outcomes.	Responds to most questions appropriately, though responses may show minor uncertainty or lack depth in technical explanation.	Responses are limited, vague, or demonstrate minimal engagement with questions or discussion.	Unable to respond meaningfully to questions or engage in discussion about the project.

2. **Technical Report Component (25%)**

Criterion	Excellent (80-100)	Good (65-79)	Pass (50-64)	Fail (0-49)
System Description and Architecture Documentation (20%)	Provides a clear, complete, and well-structured description of the final system, including architecture, components, and interactions. Documentation enables clear understanding of the system design and implementation.	Provides a generally clear system description, though some architectural details or explanations are under-specified.	Provides a basic system description with missing or unclear architectural details.	Fails to clearly describe the system architecture or overall system structure.
Implementation Details and Integration Explanation (25%)	Clearly explains system implementation and software–hardware integration, including interfaces, data flow, and key technical mechanisms, demonstrating strong technical understanding.	Explains implementation and integration adequately, though some details or explanations lack clarity or depth.	Provides limited or superficial explanation of implementation and integration.	Fails to explain system implementation or integration in a meaningful way.
Verification, Validation, and Performance Analysis (30%)	Presents systematic verification and validation activities, supported by performance analysis or testing results.	Presents basic verification and validation activities, though analysis or	Provides minimal testing or validation, with weak linkage to design objectives.	Provides no meaningful verification,

	Evidence is clearly used to demonstrate that the system meets design objectives.	interpretation of results is limited.		validation, or performance analysis.
Design Rationale, Innovation, and Practical Considerations (15%)	Clearly articulates the design rationale behind key system decisions, demonstrating thoughtful consideration of innovative aspects and practical constraints. Shows clear awareness of alternative design approaches and justifies chosen solutions in relation to intended use, constraints, and real-world applicability.	Explains design decisions with some discussion of design rationale, innovation, or practical considerations, though analysis of alternatives or justification of choices lacks depth or clarity.	Provides limited explanation of design decisions, with minimal discussion of design rationale, innovation, or practical considerations.	Provides no meaningful discussion of design rationale, innovation, or practical considerations, or fails to justify key design decisions.
Technical Writing Quality and Professional Standards (10%)	The report is well-organised, clearly written, and professionally presented, with appropriate use of figures, tables, and technical language.	The report is generally clear and well-organised, though presentation or writing quality could be improved.	The report communicates basic information but lacks clarity, organisation, or professional polish.	The report is poorly written, disorganised, or fails to meet basic professional standards.