Lingnan University

Course Syllabus

Course Title	:	Intelligent Sensing and Control
Course Code	:	CDS3101
Recommended Study Year	:	Year 3
No. of Credits	:	3
Mode of Tuition	:	Sectional Approach
Class Contact Hours	:	3 hours per week
Category	:	Major Required
Discipline	:	Nil
Prerequisite(s)	:	(a) CDS1002 Calculus, and (b) CDS2102 Networking
Co-requisite(s)	:	Nil
Exclusion(s)	:	Nil
Exemption Requirement(s)	:	Nil

Brief Course Description:

This course is designed to introduce the principles and applications of intelligent sensing technologies and advanced control systems. The course covers the fundamentals of sensors and transducers, signal acquisition, and data processing for real-time monitoring and decision-making. Students will explore various sensing modalities, including optical, acoustic, and inertial sensors, and learn how these technologies are integrated into intelligent systems. The control component focuses on classical and modern control strategies, including PID control, state-space methods, and intelligent control techniques such as fuzzy logic and neural networks. Emphasis is placed on the interaction between sensing and control in autonomous systems, robotics, and industrial automation. Practical exercises and projects involve designing and implementing sensor-based control systems using simulation tools and hardware platforms.

Aims:

The course aims to provide students with fundamental knowledge and practical skills in intelligent sensing and control, enabling them to analyse sensor data, design feedback control systems, and implement integrated sensing–control solutions in modern engineered systems.

Learning Outcomes (LOs)

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

1. Explain the operating principles and characteristics of common sensors and transducers

used in intelligent systems. (PILO1)

2. Acquire and process sensor data for monitoring, estimation, and decision-making. (PILO2, PILO4)
3. Design and analyse classical feedback control systems, including PID controllers. (PILO1, PILO2)
4. Apply state-space modelling and modern control methods to dynamic systems. (PILO1, PILO2)
5. Implement intelligent control techniques such as fuzzy logic and neural-network-based control. (PILO2, PILO4)
6. Design and implement integrated sensing and control systems for autonomous and industrial applications. (PILO2)

Indicative Contents:

Intelligent Sensing

Basic sensing principles; sensors and transducers; calibration and noise; signal acquisition and conditioning; optical, acoustic and inertial sensors; sensor fusion and distributed/networked sensing.

Control Systems

Feedback control fundamentals and stability; PID control: design and tuning; state-space modelling and modern control; intelligent control: fuzzy logic and neural networks.

Integration and Applications

Sensing-control interaction in robotics and industrial automation; autonomous and cyber-physical systems; simulation and hardware implementation.

Teaching Methods:

Teaching and learning activities include lectures and laboratories. Lectures introduce theoretical foundations and applications; laboratories emphasise simulation and hands-on implementation of sensing and control systems.

Measurement of Learning Outcomes:

Assessment / **LOs**	Class Attendance (10%)	Laboratory Sessions (30%)	Group Project (20%)	Final Examination (40%)
LO1	✓			✓
LO2		✓	✓	✓

LO3		✓	✓	✓
LO4		✓	✓	✓
LO5			✓	✓
LO6			✓	✓

1. Class Attendance and Participation (10%): This component assesses students' engagement in lectures and laboratory sessions, including preparedness, participation in discussions, and professional conduct. It primarily evaluates students' understanding of fundamental sensing and control concepts (LO1).
2. Laboratory Sessions (30%): The course includes 3 laboratory sessions, which focus on sensor data acquisition, signal processing, modelling, and control implementation using simulation tools and/or hardware platforms. Students are required to submit structured laboratory reports demonstrating technical correctness, data analysis, interpretation of results, and clarity of presentation (LO2-LO4).
3. Group Project (20%): Students work in small groups to design and implement an integrated intelligent sensing and control system for a chosen application. The project assesses system design, methodology, implementation, integration of sensing and control components, and teamwork (LO2-LO6).
4. Final Examination (40%): The final examination is a closed-book written examination. It evaluates students' overall mastery of sensing and control theories and their ability to apply analytical and problem-solving skills to practical scenarios (LO1-LO6).

Assessment:

Class Attendance and Participation	10%
Laboratory Sessions	30%
Group Project	20%
Final Examination	40%
Total	100%

Required/Essential Readings:

1. Franklin, G. F., Powell, J. D., & Emami-Naeni, A. (2010). Feedback control of dynamic systems (6th ed.). Prentice Hall.
2. Behera, L., & Kar, I. (2009). Intelligent systems and control: Principles and applications. Oxford University Press.
3. Mukhopadhyay, S. C. (2013). Intelligent sensing, instrumentation and measurements. Springer.

Recommended/Supplementary Readings:

1. Åström, K. J., & Murray, R. M. (2008). Feedback systems: An introduction for scientists and engineers. Princeton University Press.
2. Dorf, R. C., & Bishop, R. H. (2016). Modern control systems (13th ed.). Pearson.
3. Nise, N. S. (2008). Control systems engineering (5th ed.). John Wiley & Sons.
4. Ogata, K. (2010). Modern control engineering (5th ed.). Pearson.
5. De Silva, C. W. (2015). Sensors and actuators: Engineering system instrumentation (2nd ed.). CRC Press.
6. Morris, A. S., & Langari, R. (2020). Measurement and instrumentation: Theory and application (3rd ed.). Academic 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 Class Attendance and Participation (10%)

Criterion	Excellent (90-100)	Good (70-89)	Pass (50-69)	Fail (0-49)
Attendance (50%)	Attends >90% of classes punctually.	Attends ≥70% of classes; minimal lateness.	Attends ≥50% of classes; occasional lateness.	Attends <50% of classes or frequent lateness.
Engagement (20%)	Actively contributes in discussions, workshops, and team activities; frequently offers ideas or feedback.	Participates occasionally in discussions and activities.	Limited participation; responds only when prompted.	Rarely participates; disengaged during class activities.
Professional Conduct (30%)	Demonstrates high professionalism: prepared, respectful, responsible, and collaborative.	Generally professional with minor lapses.	Acceptable conduct with noticeable gaps.	Exhibits unprofessional behaviour; disrupts team/class progress.

Rubric for Laboratory Sessions (30%)

Criterion	Excellent (90-100)	Good (70-89)	Pass (50-69)	Fail (0-49)
Sensor Data Acquisition and Processing (25%)	Applies appropriate methods correctly with clear, accurate analysis.	Applies appropriate methods with minor issues.	Uses basic methods with noticeable inaccuracies.	Uses inappropriate or incorrect methods.
Design of Sensing-Control Solutions (30%)	Designs are coherent, technically sound, and thoroughly justified.	Designs are functional with reasonable justification.	Designs show only basic functionality or weak justification.	Designs are ineffective or unjustified.
Implementation and Testing (25%)	Implementation is correct and robust; testing is systematic and well documented.	Implementation mostly correct; testing adequate with minor issues.	Implementation incomplete or inconsistent; testing minimal.	Implementation incorrect; testing absent or insufficient.
Technical Communication (20%)	Report is clear, well-structured, and professionally presented (no language errors).	Generally clear and structured; minor language issues.	Understandable but lacks clarity; noticeable grammatical issues.	Unclear, poorly structured, many errors.

Rubric for Group Project (20%)

Criterion	Excellent (90-100)	Good (70-89)	Pass (50-69)	Fail (0-49)
System Design & Integration (30%)	Demonstrates effective and seamless integration of sensing and control with strong system level thinking.	Adequate integration with some limitations.	Basic integration with missing elements.	Weak or ineffective integration.
Methodology & Implementation (30%)	Methodology appropriate; implementation correct and well executed.	Methodology reasonable; implementation minor issues.	Basic methodology; implementation incomplete.	Inappropriate methodology; incorrect implementation.
Innovation & Problem Solving (20%)	Shows originality and strong problem solving ability.	Some innovation; generally good problem solving.	Limited innovation; some problem solving.	Little/no problem solving or originality.
Teamwork & Deliverables (10%)	Excellent collaboration; deliverables clear, complete, and professional.	Adequate teamwork; deliverables meet expectations.	Teamwork inconsistent; deliverables partially complete.	Poor teamwork or missing deliverables.
Individual Contribution & Professional Engagement (10%)	Makes substantial and proactive contributions; demonstrates leadership, responsibility, and consistent engagement. Contributions are clearly evidenced.	Contributes reliably with good engagement and responsibility.	Limited but identifiable contribution; engagement inconsistent.	Minimal or no meaningful contribution; lacks engagement or responsibility.

Note: Assessment of individual contribution and professional engagement is informed by peer and self-assessment, individual reflections, and documented participation records (e.g. via FeedbackFruits@Moodle), thereby ensuring fairness and transparency in the assessment process.

Rubric for Final Examination (40%)

Criterion	Excellent (90-100)	Good (70-89)	Pass (50-69)	Fail (0-49)
Explain Sensing Principles (25%)	Clear and accurate explanation of sensing principles and sensor characteristics.	Good explanation with minor inaccuracies.	Basic explanation with several inaccuracies.	Major misconceptions or incorrect explanations.
Analyse & Design Classical Control Systems (45%)	Correct, well-structured analysis/design with justified steps and correct results.-structured analysis/design with justified steps and correct results.	Generally correct with minor errors.	Basic but incomplete or partly incorrect analysis/design.	Incorrect or largely incomplete analysis/design.
Apply Intelligent Control Methods (30%)	Selects appropriate intelligent control methods; applies correctly with good interpretation.	Selects appropriate methods but with minor application issues.	Selects reasonable methods but major inaccuracies in application.	Selects inappropriate methods or applies incorrectly.