Lingnan University

Course Syllabus

Course Title	:	Internet of Things
Course Code	:	CDS2104
Recommended Study Year	:	Year 2
No. of Credits	:	3
Mode of Tuition	:	Sectional approach
Class Contact Hours	:	3 hours per week
Category	:	Major Elective
Discipline	:	Nil
Prerequisite(s)	:	CDS1001 Introduction to Programming for Data Science
Co-requisite(s)	:	Nil
Exclusion(s)	:	Nil
Exemption Requirement(s)	:	Nil

Brief Course Description:

The Internet of Things (IoT) is transforming our physical world into a complex and dynamic system of connected devices on an unprecedented scale. This course introduces students to the principles, architecture, and applications of IoT technologies. Students will learn how IoT enables communication between physical devices, sensors, and cloud platforms to create intelligent, data-driven systems. The course covers IoT architecture layers, communication protocols, and device integration, along with data acquisition, processing, and security considerations. Topics include sensor networks, wireless communication technologies (such as Wi-Fi, Bluetooth, Zigbee, and 5G), edge and cloud computing, and IoT platforms. Students will explore real-world applications in smart homes, industrial automation, healthcare, and transportation. Practical exercises and projects will involve designing and implementing IoT solutions using microcontrollers, sensors, and cloud services.

Aims:

This course aims to provide students with a comprehensive understanding of IoT technologies and their applications, fostering both technical proficiency and critical awareness.

1. Introduce the architecture, components, and enabling technologies of IoT systems.
2. Develop practical skills in designing, prototyping, and programming IoT devices and networks.
3. Explore IoT data lifecycle: collection, transmission, processing, and visualization.

4. Examine security, privacy, and ethical challenges in IoT deployments.
5. Prepare students to design and evaluate IoT solutions for real-world problems.

<u>Learning Outcomes (LOs)</u>

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

1. Explain the architecture, protocols, and key technologies of IoT systems. (PILO1)
2. Design and implement functional IoT prototypes using embedded systems and sensors. (PILO5)
3. Apply networking and data processing techniques to transmit and analyse IoT data. (PILO2)
4. Evaluate the security, privacy, and ethical implications of IoT applications. (PILO7)
5. Develop a complete IoT solution for a real-world scenario, integrating hardware, software, and cloud components. (PILO5)

<u>Indicative Contents:</u>

<u>Introduction to IoT</u>

Introduces the IoT definition, evolution, ecosystem, layered architecture, and key enabling technologies such as sensors, actuators, and microcontrollers

<u>IoT Devices & Embedded Systems</u>

Covers microcontroller platforms (Arduino, ESP32, Raspberry Pi), sensor interfacing, and power management for low-power IoT design.

<u>IoT Networking & Communication</u>

Explores wireless protocols, IP-based communication methods, and the role of edge vs. cloud computing in IoT networks

<u>IoT Data Processing & Cloud Integration</u>

Focuses on data collection, preprocessing, cloud platform integration, and visualization techniques for IoT systems

<u>IoT Security, Privacy & Ethics</u>

Examines threat models, encryption, authentication, secure updates, and privacy-by-design in ethical IoT deployment

<u>IoT Applications & Case Studies</u>

analyses real-world IoT implementations in smart environments, industrial systems, healthcare, and environmental monitoring

Teaching Methods:

The course adopts a sectional approach. Lectures deliver theoretical foundations, architectural concepts, and case studies. Weekly lab sessions provide hands-on experience with IoT hardware, programming, and cloud tools. Students will engage in individual exercises, group prototyping, and a capstone project that integrates multiple IoT components. Regular workshops, guest talks from industry practitioners, and project reviews will enhance applied learning and critical discussion.

Measurement of Learning Outcomes:

Assessment / LOs	Class Attendance and Participation	Individual Lab Assignments	Individual IoT Project	Group Project and Presentation
	(10%)	(30%)	(30%)	(30%)
LO1	✓			
LO2		✓	✓	✓
LO3		✓	✓	✓
LO4	✓		✓	✓
LO5				✓

1. **Class Attendance and Participation (10%):** Students are expected to attend all sessions and actively engage in lectures, lab activities, and discussions. Participation includes contributing to technical debates, completing in-lab exercises, and collaborating in group tasks, thereby explaining IoT concepts in context (LO1) and engaging with ethical and security considerations (LO4).
2. **Individual Lab Assignments (30%):** A series of three hands-on assignments will build foundational IoT skills. Assignment 1: Sensor Interfacing & Data Collection requires students to connect sensors to a microcontroller and log data, applying embedded system design principles (LO2). Assignment 2: IoT Communication & Protocol Implementation focuses on transmitting sensor data using MQTT or CoAP, demonstrating networking and data transmission skills (LO3). Assignment 3: Cloud Integration & Visualization involves sending data to a cloud platform and creating a real-time dashboard, applying data processing and cloud integration techniques (LO3).
3. **Individual IoT Project (30%):** Each student will design and implement a complete IoT solution for a specified problem, such as a smart environmental monitor or a

wearable health tracker. The project requires designing and implementing a functional IoT prototype (LO2), integrating data transmission and cloud components (LO3), and evaluating the system's security and ethical dimensions (LO4). Deliverables include a working prototype, source code, and a technical report.

4. **Group Project and Presentation (30%):** Teams will tackle a complex, real-world IoT challenge, such as designing a smart campus or industrial monitoring system. The project emphasizes collaborative system design and integration (LO2, LO3), critical evaluation of security and societal impact (LO4), and effective communication of technical solutions (LO5). Deliverables include a group report, prototype demonstration, and a final presentation to stakeholders.

Assessment:

Class Attendance and Participation	10%
Individual Lab Assignments	30%
Individual IoT Project	30%
Group Project and Presentation	30%
Total	100%

Required/Essential Readings:

1. Rose, K., Eldridge, S., & Chapin, L. (2015). The internet of things: An overview. The internet society (ISOC), 80(15), 1-53.
2. Soori, M., Arezoo, B., & Dastres, R. (2023). Internet of things for smart factories in industry 4.0, a review. *Internet of Things and Cyber-Physical Systems*, *3*, 192-204.
3. Rejeb, A., Rejeb, K., Appolloni, A., Jagtap, S., Iranmanesh, M., Alghamdi, S., ... & Kayikci, Y. (2024). Unleashing the power of internet of things and blockchain: A comprehensive analysis and future directions. *Internet of Things and Cyber-Physical Systems*, *4*, 1-18.

Recommended/Supplementary Readings:

1. Zhang, T., Gao, L., He, C., Zhang, M., Krishnamachari, B., & Avestimehr, A. S. (2022). Federated learning for the internet of things: Applications, challenges, and opportunities. *IEEE Internet of Things Magazine*, *5*(1), 24-29.
2. Sallam, K., Mohamed, M., & Mohamed, A. W. (2023). Internet of Things (IoT) in supply chain management: challenges, opportunities, and best practices. *SMIJ*, *2*(2), 32.

3. Sinha, B. B., & Dhanalakshmi, R. (2022). Recent advancements and challenges of Internet of Things in smart agriculture: A survey. *Future Generation Computer Systems*, *126*, 169-184.
4. Jamshed, M. A., Ali, K., Abbasi, Q. H., Imran, M. A., & Ur-Rehman, M. (2022). Challenges, applications, and future of wireless sensors in Internet of Things: A review. IEEE Sensors Journal, 22(6), 5482-5494.
5. Elgazzar, K., Khalil, H., Alghamdi, T., Badr, A., Abdelkader, G., Elewah, A., & Buyya, R. (2022). Revisiting the internet of things: New trends, opportunities and grand challenges. *Frontiers in the Internet of Things*, *1*, 1073780.

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 (80-100)**	**Good (65-79)**	**Pass (50-64)**	**Fail (0-49)**
Punctual to attend class (30%)	Always come to the class on time	Mostly come to the class on time	Sometimes come to the class on time	Seldom come to the class on time
Participation in class activities (70%)	Proactively participate in class activities, including the completion of in-class exercises, engaging in group discussion, and asking relevant questions in the Q&A session of group presentation. Demonstrate vigorous involvement	Participate as instructed in class activities including the completion of in-class exercises, engaging in group discuss, and asking relevant questions in the Q&A session of group presentation. Demonstrates ongoing involvement	Sometimes participate as instructed in class activities including the completion of in-class exercises, engaging in group discuss, and asking relevant questions in the Q&A session of group presentation. Demonstrates involvement	Seldom or never participate in class activities including the completion of in-class exercises, engaging in group discuss, and asking relevant questions in the Q&A session of group presentation. Seldom or rarely involves

1. Automated, quantitative record of sign-in time for each session: Digital attendance system (e.g., Moodle attendance tool, QR code scan). A late arrival is defined as arriving after the official session start time.
2. Structured observation using a standardized checklist aligned to rubric descriptors: Instructor/TA Checklist: A simple form for each session to log specific, observable student actions (see example below).

Rubric for Individual Lab Assignments (30%)

Assignment 1: Sensor Interfacing & Data Collection (10%)

Criterion	Excellent (80-100)	Good (65-79)	Pass (50-64)	Fail (0-49)
Hardware Setup & Wiring (30%)	Sensor connections are correct, tidy, and well-documented. Circuit is robust and follows best practices.	Connections are correct and functional. Minor issues in organization or documentation.	Basic connections are made but may be messy, unstable, or partially incorrect.	Wiring is incorrect, unstable, or incomplete; circuit does not function.
Code Quality & Functionality (40%)	Code is clean, well-commented, and runs without errors. Data collection is accurate, timed appropriately, and logged systematically.	Code is functional and mostly clear. Data collection works with minor issues (e.g., timing drift, occasional errors).	Code runs but may contain bugs, poor structure, or incomplete functionality. Data logging is inconsistent.	Code does not run, is poorly written, or fails to collect/store data as required.
Data Accuracy & Documentation (30%)	Collected data is accurate, properly formatted, and clearly documented. Includes calibration notes and environmental context if relevant.	Data is mostly accurate and documented adequately. May lack some contextual details.	Data contains errors or inconsistencies; documentation is brief or unclear.	Data is missing, largely inaccurate, or undocumented.

Assignment 2: IoT Communication & Protocol Implementation (10%)

Criterion	Excellent (80-100)	Good (65-79)	Pass (50-64)	Fail (0-49)
Protocol Implementation (40%)	Correctly implements MQTT/CoAP with appropriate topic structure, QoS settings, and error handling. Communication is stable and efficient.	Protocol is implemented correctly with basic functionality. May lack advanced features or robustness.	Implementation works partially but may have connectivity issues, incorrect topic usage, or limited error handling.	Protocol implementation fails or does not meet basic functional requirements.
Data Transmission & Reliability (30%)	Data is transmitted consistently, with no loss or corruption. Includes acknowledgments, retry logic, and network resilience features.	Data transmission is mostly reliable. Occasional packet loss or delays may occur.	Transmission is unstable; data may be lost, delayed, or incorrectly formatted.	Data is not transmitted or transmission is fundamentally flawed.
Code Structure & Documentation (30%)	Code is modular, well-documented, and includes clear configuration instructions. Demonstrates understanding of protocol mechanics.	Code is functional and reasonably documented. Configuration may require minor adjustments.	Code is monolithic or poorly organized; documentation is minimal or unclear.	Code is undocumented, disorganized, or not submitted in usable form.

Assignment 3: Cloud Integration & Visualization (10%)

Criterion	Excellent (80-100)	Good (65-79)	Pass (50-64)	Fail (0-49)

Cloud Platform Integration (40%)	Successfully sends data to cloud service (e.g., AWS IoT, ThingSpeak) with proper authentication, topic structure, and error handling. Data ingestion is seamless.	Data is sent to cloud platform correctly. May have minor issues with formatting or intermittent connectivity.	Cloud integration works but with noticeable issues (e.g., authentication failures, data format mismatches).	Cloud integration fails or is not attempted.
Dashboard Design & Visualization (30%)	Dashboard is visually clear, interactive, and effectively communicates data trends. Uses appropriate charts, labels, and real-time updates.	Dashboard is functional and presents data adequately. May lack polish or advanced interactivity.	Dashboard is basic, static, or poorly designed; visualization choices may be inappropriate.	Dashboard is missing, incomplete, or does not display data correctly.
End-to-End System Functionality (30%)	Entire pipeline—from sensor to cloud to dashboard—operates smoothly and reliably. System is well-documented and reproducible.	Pipeline works with minor interruptions or delays. Documentation is adequate.	Pipeline is partially functional; may have broken links or inconsistent behaviour.	Pipeline does not function as an integrated system.

Rubric for Individual IoT Project (30%)

Criterion	Excellent (80-100)	Good (65-79)	Pass (50-64)	Fail (0-49)
Problem Definition & System Design (20%)	Clearly articulates a real-world problem with well-defined requirements. System architecture is innovative, scalable, and appropriately layered (sensor → edge → cloud).	Problem is well-defined and relevant. Architecture is logical and covers key IoT layers.	Problem statement is somewhat vague. Architecture is basic but functional; may lack detail or justification.	Problem is unclear or irrelevant. Architecture is poorly designed, incomplete, or misaligned with IoT principles.
Hardware Implementation & Sensor Integration (25%)	Hardware setup is robust, sensor selection is well-justified, and wiring is professional. Demonstrates attention to power management, signal integrity, and physical design.	Hardware functions correctly; sensor integration is appropriate. Minor issues may exist in wiring or component choice.	Hardware works but may be unstable, poorly integrated, or overly simplistic. Sensor choices may not fully align with problem needs.	Hardware is non-functional, incorrectly connected, or fails to meet project requirements.
Software Development & Communication (25%)	Code is modular, well-documented, and efficiently implements data collection, local	Code is functional and adequately structured. Communication works but may lack advanced	Code runs but may be monolithic, poorly documented, or prone to failures.	Code is incomplete, non-functional, or fails to enable device communication.

	processing, and reliable communication (e.g., MQTT, Wi-Fi, BLE). Includes error handling and logging.	features or robustness.	Communication is unstable or limited.	
Cloud Integration & Data Processing (15%)	Seamlessly integrates with cloud platform (e.g., AWS IoT, Google Cloud). Implements data ingestion, storage, processing, and real-time visualization in a polished dashboard.	Cloud integration works; data is stored and visualized adequately. May lack advanced processing or dashboard interactivity.	Basic cloud connection is established but may have data loss, formatting issues, or a minimal dashboard.	Cloud integration is missing, broken, or does not support meaningful data flow.
Security, Ethics & Critical Evaluation (15%)	Proactively addresses security risks (encryption, access control) and ethical considerations (privacy, sustainability). Includes a thorough evaluation of system limitations and societal impact.	Identifies key security and ethical issues. Evaluation is sound but may lack depth or specific mitigation strategies.	Mentions security/ethics superficially. Evaluation is descriptive rather than analytical.	Security and ethical dimensions are ignored or poorly addressed. Evaluation is absent or irrelevant.

Rubric for Group Project and Presentation (30%)

Criterion	Excellent (80-100)	Good (65-79)	Pass (50-64)	Fail (0-49)
Problem Analysis & Solution Design (20%)	Problem is thoroughly researched, clearly defined, and contextualized within real-world needs. Proposed IoT solution is innovative, well-architected, and clearly justified.	Problem is well-understood and defined. Solution is logical, relevant, and appropriately designed.	Problem statement is somewhat vague. Solution is functional but may lack innovation or detailed justification.	Problem is poorly defined. Solution is impractical, incomplete, or misaligned with IoT principles.
Technical Implementation & Integration (30%)	System integrates multiple IoT components (sensors, communication, cloud, UI) seamlessly. Code is robust, modular, and well-documented. Demonstrates technical sophistication and reliability.	Core IoT components are implemented and integrated effectively. System functions as intended with minor issues.	Basic integration is achieved but may have instability, incomplete features, or technical gaps.	System is poorly integrated, non-functional, or fails to demonstrate core IoT competencies.
Collaboration & Project Management (20%)	Team demonstrates exceptional collaboration,	Team works well together with clear responsibilities.	Collaboration is functional but uneven; some members may	Teamwork is disjointed, roles are unclear, or project

	clear role division, and effective use of version control (e.g., Git). Project is well-paced, with milestones consistently met.	Project management is adequate and mostly on schedule.	be less engaged. Timeline may have delays or scope adjustments.	management is ineffective. Significant delays or coordination issues.
Presentation & Communication (15%)	Presentation is engaging, professional, and clearly structured. Visual aids are effective, and the team communicates technical content with clarity and confidence. Q&A responses are insightful.	Presentation is clear and well-organized. Key points are communicated effectively, with adequate visual support.	Presentation is understandable but may lack polish, clarity, or engagement. Visuals are basic.	Presentation is disorganized, unclear, or fails to convey the project's value and functionality.
Ethical & Security Awareness (15%)	Proactively addresses security measures (encryption, authentication) and ethical implications (privacy, sustainability). Includes a well-reasoned evaluation of	Identifies relevant security and ethical considerations. Evaluation is sound but may lack depth or specific mitigation strategies.	Security and ethics are mentioned but not deeply integrated or analysed. Evaluation is descriptive.	Little to no consideration of security, ethics, or societal impact. Evaluation is absent or superficial.

	societal impact and potential risks.			