Subject Description Form

Subject Code	COMP3424
Subject Title	Digital Twins: Simulation and Case Studies
Credit Value	3
Level	3
Pre-requisite / Co-requisite / Exclusion	**Pre-requisite**: COMP1011/COMP1012/ENG2002 & COMP2011/COMP2013
Objectives	This subject enables students to understand the basic concept of digital twins and how they work for industrial applications. Computer simulation (discrete event simulation) can be served alternative or foundation stage of digital twins. Applications from built environment, government, manufacturing, logistic and supply chain, STEAM education, smart cities, will be reviewed. The students should be able to propose, design, and implement digital twins / simulation applications by combining emerging technologies and processes, software, artificial intelligence and machine learning, IoT, virtual reality, and metaverse, etc.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) show a clear understanding of the fundamentals of digital twins, and the benefits of using digital twins. b) understand the various key enabling technologies of digital twins such as IoT and the process of creating digital twins. c) demonstrate a clear understanding of the fundamentals of simulations and the benefits. d) connect digital twins / simulations to artificial intelligence / machine learning platform for advanced applications. e) apply the technologies of digital twin and simulations in potential industries such as manufacturing, automobile, government, smart cities, STEAM educations, logistics and supply chain.

<table>
<tr><td>Subject Synopsis/ Indicative Syllabus</td><td>
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<tr><th>Topic</th></tr>
<tr><td>1. Introduction to Digital Twins
About the basic digital twins history, evolution, current status, and successful cases.</td></tr>
<tr><td>2. Introduction to Simulations
About the discrete event simulations, application, and its potential linkage to digital twins.</td></tr>
<tr><td>3. The process of Digital Twins methodology
The project management methodology when developing digital twins applications.</td></tr>
<tr><td>4. Foundation of Internet of Things (IoT) and applications
Basic theory of IoT and its usage in digital twins applications.</td></tr>
<tr><td>5. Logistics and Supply Chain Management in Digital Twins and simulations
Fundamental logistic and supply chain management, and now they demand digital twins and simulation applications</td></tr>
<tr><td>6. Substantiality, Smart Cities, STEAM education, and other applications for digital twins.
Other potential applications which require digital twins and simulations</td></tr>
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<tr><td>Teaching/ Learning Methodology</td><td>The subject is comprised of lectures, laboratories, group project, tests / examination.

During lectures, students are taught the important concepts, principles, and technologies that support digital twins and relevant applications.

In laboratories, students will learn and experiment with contemporary tools such as Flexsim, Nvidia Omniverse, etc.

In the group project, small group discussions will be encouraged, and students will need to present their results and solutions in the form of reports and presentations.

Students are also encouraged to give seminar talks about topics and case studies relevant to digital twins and relevant applications to reinforce their understanding of the knowledge taught and to explore further topics.</td></tr>
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Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)				
		a	b	c	d	e
1. Assignments and Tests	30%	✓	✓	✓	✓	✓
2. Group Project	30%	✓	✓	✓	✓	✓
3. Examination	40%	✓	✓	✓	✓	✓
Total	100%					

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:
Students will be assessed by their performance in three parts: 1) Assignments and Tests, 2) Group Project, and 3) Examination.

- Assignments and tests aim to assess students' abilities to comprehend basic concepts and principles.
- Group Project involves a group of students designing and implementing a solution for a practical digital twin and related application. In the project, students will collaboratively work together to apply what they have learned in the class to solve practical problems.
- The subject will have a final exam.

Student Study Effort Expected

Class contact:	
▪ Lecture	26 Hrs.
▪ Tutorial/Lab	13 Hrs.
Other student study effort:	
▪ Assignments, tests, Projects, Exam	66 Hrs.
Total student study effort	105 Hrs.

Reading List and References

Reference Books:

1. The Digital Twin
   Crespi, Drobot, Minerva, Springer, 2023
2. FlexSim in Academe: Teaching and Research
   Pawlewski, Pawel; Hoffa-Dabrowska, Patrycja; Golinska-Dawson, Paulina; Werner-Lewandowska, Karolina, Springer; 2019; 1st ed. 2019.
3. "Digital Twin Technology" Gopal Chaudhary, Manju Khari, Mohamed Elhoseny, CRC Press, 2021
4. "Digital Twin Technologies and Smart Cities (Internet of Things)", Maryam Farsi, Alireza Daneshkhah, Amin Hosseinian-Far, Hamid Jahankhani, Springer, 2020
5. "Building Industrial Digital Twins", Shyam Varan Nath, Pieter van Schalkwyk, Dan Isaacs, Packt Publishing, 2021