CV4108 DIGITAL AND ROBOTIC CONSTRUCTION

Academic Year	2024-25	Semester	1
Course Coordinator			
Course Type	Major Prescribed Elective		
Pre-requisites	CV0003 Introduction to Data Science and Artificial Intelligence		
AU	3		
Grading	Letter Grading		
Contact Hours	39 (26 hours Lecture & 13 hours Tutorial)		
Proposal Date	5 June 2023		

Course Aims

The global construction industry is shifting towards digitalisation and robotic automation, expecting significant values to be derived from emerging digital and robotic technologies. This course aims to equip students with knowledge and skillsets on digital and robotic construction for this industry-wide transition, in understanding the true power of recent emerging technologies. Specifically, the course will introduce the principles and fundamentals of digital/ robotic technologies, and its applications, as well as future of the construction industry as well as provide an overview of current initiatives associated with digital and robotic construction in Singapore and worldwide.

Intended Learning Outcomes (ILO)

By the end of this course, student will be able to:

1. understand current trends and transitions towards digitalisation and robotic automation in the construction industry;
2. identify cutting-edge applications of digital and robotic technologies;
3. explain and discuss fundamentals digital and robotic technologies that are actively being adopted in construction; and
4. shape and discuss your own thoughts and perspectives on the potentials, challenges, and future directions of digital and robotic construction.

Course Content

No	Topic	Lecture Hours	Tutorial Hours
1	Introduction to Digital and Robotic Construction	2	1
2	AI and Deep Learning – Backgrounds and State-of-the-Art	4	2
3	Computer Vision and Visual Analytics	4	2
4	Signal Pattern Recognition and Wearable Sensors	4	2
5	Natural Language Processing and Document Analysis	4	2

6	Virtual/Augmented Reality, Digital Twin, and Simulation	4	2
7	Deep Reinforcement Learning and Robotic Systems	2	1
8	Future of the Construction Industry	2	1
	Total	**26**	**13**

Assessment (Includes both continuous and summative assessment)

Component	ILO Tested	EAB Graduate Attributes	Weightage	Team / Individual	Rubrics
1. CA1: Quiz 1	1, 2, 3	(a), (b), (d), (e)	20%	Individual	N.A.
2. CA2: Quiz 2	2, 3	(a), (b), (d), (e)	20%	Individual	N.A.
3. Final Examination	2, 3, 4	(a), (b), (c), (d), (f), (g), (h), (l)	60%	Individual	N.A.
Total			**100%**		

EAB Graduate Attributes[1]	
a)	**Engineering Knowledge** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
b)	**Problem Analysis** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c)	**Design / Development of Solutions** Design solutions for complex engineering problems and design systems, components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d)	**Investigation** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e)	**Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f)	**The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g)	**Environment and Sustainability** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h)	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

[1] *Reference: EAB Accreditation Manual*

i)	**Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j)	**Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k)	**Project Management and Finance** Demonstrate knowledge and understanding of the engineering management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l)	**Life-long Learning** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Formative Feedback

You will be asked to answer some questions associated with what you learnt from the lectures. Feedback will be provided on your incorrect answers and explanations for correct answers, while discussing with other students.

Feedback will be provided to students through evaluation of their submissions for their quizzes, quiz answers will be discussed in the class. You will also see the average grades of students in the same cohort.

Learning & Teaching Approach

Approach	How does this approach support students in achieving the learning outcomes?
LEC	Topics will be delivered as a series of face-to-face lectures, and you will also be provided reference materials for self-study to achieve the ILOs.
TUT	Tutorials will be formed for students to discuss, debate and clarify the contents of the lectures, as well as to answer some questions with theoretical knowledge on digital and robotic technologies, to achieve the ILOs.

Readings & References

There is no single textbook for the course. The following resources will be used as references.

1. Deep Learning Specialization by Coursera (2023), https://www.coursera.org/specializations/deep-learning

2. Deep Learning for Computer Vision by Stanford (2017), https://youtube.com/playlist?list=PLf7L7Kg8_FNxHATtLwDceyh72QQL9pvpQ

3. Natural Language Processing with Deep Learning by Stanford (2023), https://web.stanford.edu/class/cs224n/

4. Reinforcement Learning Specialization by Coursera (2023), https://www.coursera.org/specializations/reinforcement-learning

Additional resources, if required, will be shared with you in the lectures and tutorials.

Course Policy & Student Responsibility

(1) General

Students are expected to complete all assigned pre-class readings and activities, attend all classes punctually and take all scheduled assignments and tests by due dates. Students are expected to take responsibility to follow up with course notes, assignments and course-related announcements for sessions they have missed. Students are expected to participate in all discussions and activities.

(2) Absenteeism

Absence from quiz session without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for in-class activities.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognise your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain about the definitions of any of these terms, you should refer to the Academic Integrity at NTU (sharepoint.com) for more information.

On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning.

Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office	Phone	Email

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/Activities
1	Introduction to Digital and Robotic Construction	1, 2, 4	Lecture and Tutorial
2-3	AI and Deep Learning – Background and State-of-the-Art	1, 2, 4	Lecture and Tutorial
4-5	Computer Vision and Visual Analytics	2, 3	Lecture and Tutorial
6-7	Signal Pattern Recognition and Wearable Sensors	2, 3	Lecture and Tutorial
8-9	Natural Language Processing and Document Analysis	2, 3	Lecture and Tutorial
10-11	Virtual/Augmented Reality, Digital Twin, and Simulation	2, 3	Lecture and Tutorial
12	Deep Reinforcement Learning and Robotic Systems	2, 3	Lecture and Tutorial
13	Future of the Construction Industry	3, 4	Lecture and Tutorial