Subject Description Form

Subject Code	BRE506
Subject Title	Principles of Project Management
Credit Value	3
Level	5
Pre-requisite / Co-requisite/ Exclusion	Nil
Objectives	This subject aims to enrich students' knowledge and skills in project management.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Understand the principles of Project Management Body of Knowledge (PMBOK); b. Learn the skills in managing projects with cross-functional teams and external parties; c. Apply project management techniques at workplaces aiming at shorter lead time, reduced costs, improved quality and enhanced relationship with the concerned parties.
Subject Synopsis/ Indicative Syllabus	**Overview of project management:** characteristics of project; characteristics of project management; defining project management; responsibilities of project managers; meaning of PMBOK. **Project integration management:** definition of integration management; project stakeholders; project objectives and trade-offs; project life cycles; project plan; project execution; overall project change. **Project scope management:** meaning of scope; development of a project charter; scope statement; work breakdown structure (WBS). **Project time / schedule management:** project master schedules; defining activities; estimating activity durations; logic networks; methodology for network analysis; identifying the critical path; schedule control. **Project cost management:** meaning of cost management; process of cost management; resource planning; cost estimating; cost budgeting; cost control; value management. **Project quality management:** source of failure; possible causes for cost related errors; overview of quality management; quality planning; quality assurance; quality control. **Project resource management:** overview of project human resource management; organizational planning; estimating activity resources; staff acquisition; team development. **Project communications management:** general communication concept; process of project communication; best practice for project communication.

	Project risk management: process of project risk management; risk identification; risk quantification; risk response development; risk response control. **Project procurement management:** process of procurement management; procurement planning; solicitation planning; solicitation; source selection; contract administration; contract close-out. **Project stakeholder management:** process of identifying stakeholders; process of planning stakeholder management; process of managing stakeholder engagement; process of controlling stakeholder engagement.
Teaching/Learning Methodology	Lectures and seminars will be run throughout the semester period. A lecture schedule outlining the topics to be discussed throughout the three weekend daytime workshops will be informed to students in the first lecture of the semester. During the lecture period, the lecturers will introduce and discuss the topics, with frequent reference to, and examination of, the recommended textbook, published research papers or other reference materials whenever deemed appropriate. Apart from the face-to-face lecture classes, students are required to form small groups to write a group assignment report based on a set of assigned questions and scenarios in relation to project management in the construction sector or other industry sectors. Students are encouraged to apply their concepts and knowledge learned from the subject, and their hands-on working experience at their workplaces, to tackle the assignment questions. It is the students' ultimate responsibilities to ensure that no plagiarism is committed in their group assignment reports. So students should have checked their works against plagiarism by using some common plagiarism detection and scanning tools (e.g. Turnitin program) before submitting their completed group reports for assessment. Students should submit and retain their "final scanned" electronic copy of their completed group written reports (with the Similarity Index and AI-text Indicators shown) at the same location of the blackboard subject website for perusal and inspection by the subject lecturers. **If students intend to use Generative AI (GenAI) tools for brainstorming or generating initial ideas, literature search or writing of group assignment reports, they are required to declare the use of such tools (e.g. ChatGPT, Poe, Google Bard, Microsoft Bing AI, etc) in preparing their submitted work, and where and how they have been used, in the preface of their group report and to submit their interactive chat history file including the writing prompts with the AI chatbots as written evidence in students' work without plagiarism.** If students have adopted AI-generated texts or materials in their work, they must properly cite and reference them in accordance with accepted academic conventions and citation styles. Students may refer to the *Guidelines for Students on the Use of Generative Artificial Intelligence* (source: https://www.polyu.edu.hk/ar/students-in-taught-programmes/use-of-genai) developed by the Academic Registry (AR) of PolyU for reference.

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.			
1. Coursework (Individual assignment and Group written report	50%	✓	✓	✓			
2. Examination (2 hours)	50%	✓	✓	✓			
Total	100 %						

Students are required to pass all the specific assessment methods / tasks (**both coursework and examination separately**) in order to pass the whole subject.

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Coursework (Individual assignment and Group written report)

The designed individual and group assignment questions are intended to assess the level of students' knowledge and understanding of various underlying functions of project management as defined by the PMBOK Guide used for projects, and then to apply learned knowledge and their hands-on working experience at their workplaces to perform main project management functions on different types of construction projects.

The individual assignment requires students to develop a project plan and schedule for a small wooden house construction project, with emphasis on project description including products, processes and logical sequences, project network diagramming to facilitate the communication of project management in general, and to lay the basis for project planning and scheduling in particular. The group-based assignment requires writing a "method statement" report based on the project information as provided to communicate the project development and construction processes to all the stakeholders while making connections with those relevant basic functions as defined by the Project Management Body of Knowledge (PMBOK) Guide.

Examination (2 hours)

The examination questions attempt to test students' knowledge and understanding of various underlying functions of project management as defined by the PMBOK Guide used for projects, and then to analyze different hypothesized scenarios to provide straight answers or logical arguments by citing relevant both local and international case study projects for proper illustration.

Reading List and References	1. Dennis P. Slevin, David I. Cleland and Jeffrey K. Pinto (2004). *Innovations: Project Management Research*. 2. David I. Cleland and Lewis R. Ireland (2010). *Project Manager's Portable Handbook*, 3rd edition. 3. Development Bureau (2018). *Construction 2.0 - Time to Change*, Report of the Project Cost Management Office, Development Bureau, Hong Kong SAR Government, Hong Kong on the future of the local construction industry - the challenges and how these can be addressed, September, 53 pages (URL: https://www.psgo.gov.hk/en/c20.html). 4. Erling S. Andersen, Kristoffer V. Grude and Tor Haug (2009). *Goal Directed Project Management: Effective Techniques and Strategies*, 4th edition. 5. Frederick Harrison and Dennis Lock (2016). *Advanced Project Management: A Structured Approach*, 4th edition. 6. Gary Heerkens (2006). *The Business-savvy Project Manager: Indispensable Knowledge and Skills for Success* 7. Harold Kerzner (2004). *Advanced Project Management: Best Practices on Implementation*, 2nd edition. 8. Harold Kerzner (2022). *Project Management: A Systems Approach to Planning, Scheduling and Controlling*, 13th edition. 9. John M. Nicholas and Herman Steyn (2017). *Project Management for Engineering, Business and Technology*, 5th edition. 10. Paul A. Tedesco (2006). *Common Sense in Project Management*. 11. Project Management Institute (2013). *A Guide to the Project Management Body of Knowledge (PMBOK Guide 2013)*, 5th edition. 12. Project Management Institute (2017). *A Guide to the Project Management Body of Knowledge (PMBOK Guide 2017)*, 6th edition. 13. Project Management Institute (2021). *A Guide to the Project Management Body of Knowledge (PMBOK Guide 2021)*, 7th edition. 14. Rodney J. Turner (2016). *Gower Handbook of Project Management*, 5th edition. 15. Scott Berkun (2005). *The Art of Project Management*. 16. Thomas E. Uher and Martin Loosemore (2004). *Essentials of Construction Project Management*.

Subject Description Form

Subject Code	BRE511
Subject Title	Information Management for Construction and Real Estate
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	This subject aims at understanding of how data and information is designed, created, used and managed in the construction industry with emphasis on information modelling and management at the project and organization levels.
Intended Learning Outcomes	By the end of this subject, students will be able to: a. understand the basic concepts of the creation and management of data and information within construction projects; b. understand contemporary issues in information management at project and organization level; c. apply basic building modelling knowledge to construction projects through the selection, development and implementation of information systems.
Subject Synopsis/ Indicative Syllabus	Information systems: information management; e.g. information distribution, access, securing and control; the strategic management of information and communication technologies assessing the business benefits of information technologies, knowledge management, IT and organization change. Understand current information systems and management procedures within the construction industry; relevant legislation impact of information systems; building information modelling; integrated property and construction industry databases; and construction project-based systems. Case studies from both large and small construction organizations will be used to illustrate current systems within the industry.

Teaching/Learning Methodology	• Lectures
	• Training exercises on information systems (including Microsoft Project, Autodesk Revit and Navisworks)
	• Independent study and teamwork
	  • Assignments
	  • Individual and team projects
	  • Case study and presentation

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			
1. Assignment	30%	✓	✓	✓			
2. Individual Report	30%	✓	✓	✓			
2. Group Report	40%	✓	✓	✓			
Total (Continuous Assessment*)	100 %						

*Students are required to achieve grade D or above in overall subject grade to pass the subject.

Assignments require students to work on questions to help them for understanding of fundamental knowledge of the management of data and information within construction projects.

Individual projects require students to work individually and submit an individual report that is focused on topics of IT-related information management application in construction projects.

Students will also need to work in a project team for the group project. Group project will be focused on potential applications of IT systems, BIM, AI, and Big Data analytics to solve existing practical problems during the life cycle of a construction project. By working together in a team environment and working on real-world working practices, students will be able to test information-management practices in the way to become creative and innovative practitioners.

Reading List and References

Shen, Q.G., Brandon, P., & Baldwin, A., (2009) Collaborative Construction Information Management, Taylor & Francis.

Eastman, C., Eastman, C.M., Teicholz, P., Sacks, R. & Liston, K. (2011). BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, John Wiley & Sons.

Smith, D.M. & Tardi, F.M. (2009) Building information modeling: a strategic implementation guide for architects, engineers, constructors, and real estate asset managers, Jolm Wiley and Sons.

Electronic Journal of Information Technology in Construction, www.itcon.org.

CIC, Construction Industry Council (2014), Roadmap for Building Information Modelling in Hong Kong's Construction Industry.

CIC, CIC BIM Standards – General (August 2019); (Version 2 - December 2020) and (Version 2.1 - 2021)

	CIC BIM Standards for Architecture and Structural Engineering (Version 2 - December 2020); and (Version 2.1 - 2021); CIC BIM Dictionary (December 2020); and (2021);

Subject Description Form

Subject Code	BRE534
Subject Title	Integrated Project in Intelligent Construction
Credit Value	3
Level	5
Pre-requisite	BRE587 Research Methods for Construction and Real Estate
Objectives	This subject is intended to: a. Develop capability of critical investigation, analysis and synthesis in solving problems in Intelligent Construction professional context. b. Develop capability for identifying, collecting, analyzing and presenting information to finding solutions to the practical problems in Intelligent Construction. c. To integrate the core subjects of Intelligent Construction study into real-world case studies.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. select and pursue in depth, a non-trivial topic relevant to professional practice in the field of Intelligent Construction; b. complete a substantial piece of work autonomously, with guidance from a supervisor but without detailed day-to-day supervision; c. formulate a set of questions in a way that renders them amenable to rigorous investigation; d. discriminate and identify in the available written material which is useful to the topic under investigation; e. identify and make use of methods of investigation appropriate to the subject; f. draw conclusions that are based on the work undertaken and relevant to Intelligent Construction and assess the limitations of those conclusions; g. write up a comprehensive report and present an individual project in an appropriate style.
Subject Synopsis/ Indicative Syllabus	The key learning strategy for the subject is that of learning by doing. Students are expected to work independently and individually, reflecting on the experience of the work in progress and feedback from the supervisor. The principle educational aims for the subject are to promote the following abilities and disciplines: • Self-learning • Independence of thought • Critical evaluation • Formulation and research of complex problems • Communication of complex ideas and conclusions

<table>
<tr><td>Teaching/Learning Methodology</td><td>The subject consists of an introduction workshop at the first week (one lecture) of the semester outlining the requirement of the subject. Students then submit their research proposal and will be allocated supervisors according to their areas of research interest. Students will then work independently and meet with their supervisors regularly in the tutorials (13 weeks) for supervision. Students are required to submit the final reports for assessment.
• Individual presentation
• Independent study
• Individual assignment
• Self-study</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="5">Intended subject learning outcomes to be assessed (Please tick as appropriate)</td></tr>
<tr><td>a., b.</td><td>c., d.</td><td>d., e.</td><td>f.</td><td>g.</td></tr>
<tr><td>1. Proposal</td><td>15%</td><td>✓</td><td>✓</td><td></td><td></td><td>✓</td></tr>
<tr><td>2. Research-based paper</td><td>85%</td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Total(Continuous Assessment*)</td><td>100%</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
*Students are required to pass all the specific assessment methods/tasks to pass the subject.
Writing research proposal will develop students’ skills in the preparation of a research proposal for a chosen topic, including design of study, conduct of literature review, and test of the feasibility of proposed research.
Writing research-based paper will develop students’ capacity for conducting an independent, analytical study in the area of Intelligent Construction in professional and academic context.</td></tr>
<tr><td>Reading List and References</td><td>Carlo Domingo Casinto (2019), Doing Academic Research with Ease: Five Basic Methods Every Novice Researcher Should Know, KDP Print US.
Pagadala Suganda Devi (2017), Research Methodology: A Handbook for Beginners, Notion Press.
Fellows, R. and Liu, A. (2008), Research Methods for Construction, 3rd Edition, Wiley-Blackwell.
Lester J.D. and Lester J.D. (2007). Writing Research Papers; a complete guide, 12 Edition, Longman.</td></tr>
</table>

Subject Description Form

Subject Code	BRE535
Subject Title	Advanced Visualization and Interactive Technologies for Construction
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	This subject is intended to: 1. Equip students with a holistic understanding of eXtended Reality (XR) concepts and how different visualization and interactive technologies have been using in current construction practice to achieve digital construction management. 2. Be aware of the range of visualization and interactive technologies available for construction and gain an understanding of the key concepts determining classification, features and applications.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Relate basic technical vocabulary and terminology for various visualization and interactive technologies in construction. b. Possess knowledge of fundamental principles of visualization and interactive technologies c. Acquire preliminary skills to design, program, and establish corresponding visualization and interactive environment for construction. d. Relate the inter-relationships among visualization/interactive technologies with construction practices and derived applications e. Interpret and extract information from existing digital construction details with visualization and interactive technologies.
Subject Synopsis/ Indicative Syllabus	The subject contains three teaching packages as below: **<u>Digital Visualization Principles (4 lectures)</u>**: • Introduction to visualization and interactive technologies • Object transformation, viewing, projection, and lighting • Rigid body motion and physics in the virtual environment • Modelling theorems and data visualization

Visualization Aids and Interfaces (4 Lectures):

- Human computer interaction and usability
- Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR), Immersive visualization and cooperative environment
- CAD, BIM, and digital twins

Visualization/Interactive Applications in Construction (5 Lectures):

- Visual communication and gestures in construction
- Construction inspection and progress monitoring
- Construction equipment modelling and planning
- Construction productivity analysis
- On-site safety management and occupational safety and health

Teaching/Learning Methodology

The mode of delivering the subject comprises lectures and tutorials. Lectures aim at delivering the basic core concepts and knowledge about visualization and interactive technologies in construction, which are to be discussed and consolidated through tutorials.

Furthermore, tutorials are also used for students' exercises technically on visualization and interactive toolkits, environment and applications, providing hands-on experience to students on selected topics.

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. Tutorial Exercises	25%	√	√	√			
2. Assignments	25%	√	√	√	√		
3. Term Project	50%	√	√	√	√	√	
Total (Continuous Assessment*)	100 %						

*Students are required to pass all the specific assessment methods/tasks to pass the subject.

Tutorial exercises throughout the entire semester on each session will be used to assess students' learning outcomes on the basic knowledge learned from the lecture sessions.

Two assignments, explicitly looking for potential solutions to two construction-related problems, will be used for students to practice and enhance learning outcomes.

	The term project allows students to choose specific topics on applications of visualization and interactive technologies in construction. They have to conduct in-depth study and this can enhance the depth of the knowledge learned through the potential implementation and integration upon their creativity. No examination is required in this subject.
Reading List and References	Textbooks are not compulsory in the subject, while some supplementary readings to enhance students' understanding are listed below: Hughes, J. F., van Dam, A., McGuire, M., Sklar, D. F., Foley, J.D., Feiner, S. K. and Akeley K. (2013) Computer Graphics: Principles and Practice, 3rd edition, Addison-Wesley Professional Peurifoy, R. L., Schexnayder, C. J., Schmitt, R. and Shapira, A. (2018) Construction Planning, Equipment, and Methods, 9th Edition, McGraw-Hill Education Rubin, J. and Chisnell, D. (2008) Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests, 2nd edition, Wiley Well, R. (2020) Unity 2020 By Example: A project-based guide to building 2D, 3D, augmented reality, and virtual reality games from scratch, 3rd Edition, Packt Publishing

Subject Description Form

Subject Code	BRE536
Subject Title	Automation and Robotics in Construction
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	This subject is specially devised for master students of the MSc in Digital Construction programme offered by the Department of Building and Real Estate. Its objectives are to: (a) Enthuse the students about digital construction, especially construction automation and robotics; (b) Cultivate students' creativity, problem-solving ability, and global outlook; (c) Expose students to the concepts and an understanding of sensing technologies, robotics, and their application in construction.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) Understand the necessity of involving automation and robotics in construction; (b) Understand the multi-disciplinary nature of the construction industry; (c) Understand the use of sensing technology and robotics; (d) Demonstrate creative and critical thinking, global outlook, problem solving and communication abilities for addressing issues in the construction industry with sensing and robotic technologies.
Subject Synopsis/ Indicative Syllabus	The subject will cover the following content: **Emerging imaging and sensing technologies for the construction industry:** Introduction to emerging imaging and sensing technologies for 3D reconstruction of construction sites, location and action tracking of construction equipment and personnel, and their integrations with digital modelling technologies for automating the monitoring of construction progress, productivity, safety, and quality. **Robots and exoskeletons in construction:** Introduction to the fundamentals of robotic systems and their components. Introduction to basic types of construction robots and exoskeletons in use or development today as well as their applications. Discussion on the benefits and barriers of deploying robotic and exoskeleton technologies into the construction industry, including potential safety and ethical issues, and prospects for building

	automated or smart construction sites with these technologies in the future.
Teaching/Learning Methodology	The teaching and learning methodology involve inspirational lectures, group work, assignments, and practitioners'/alumni' seminars. The knowledge gained from the inspirational lectures in the subject constitute a part of the foundation for students in developing their creative thinking and problem solving abilities. Practitioners'/alumni' seminars are arranged to introduce students how the knowledge is applied in practice, the gap between theory and practice in the industry. Through the project group work, students are expected to base on what they learn through lectures and practitioners'/alumni' seminars to come up with pragmatic solutions/ideas that demonstrate their creative thinking, problem solving, global outlook and entrepreneurship abilities for addressing issues in construction with automation and robotics.
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		
1.Assignment	40%	✓	✓	✓			
2. Project group work	60%	✓	✓	✓	✓		
Total (Continuous Assessment*)	100 %						

*Students are required to pass all the specific assessment methods/tasks to pass the subject.

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

The assessment task 1 is knowledge-oriented and plays a part in addressing the intended learning outcomes (a) – (c) covered in inspirational lectures. The assessment task includes four assignments.

The assessment task 2 is high-order in nature and the project group work serves as a main and effective assessed task (i.e., 60% of the overall assessment grade) for students to demonstrate their overall attainment of intended learning outcomes (a) – (d) at the end of the curriculum.

Reading List and References	ASCE Journal of Computing in Civil Engineering (http://www.asce.org) Elsevier Journal of Automation in Construction. (http://www.elsevier.com/locate/autocon)

	Brilakis, I. & Haas, C. (2019). Infrastructure Computer Vision (1st ed.), Butterworth-Heinemann Bock, T., & Linner, T. (2015). Robot-Oriented Design (The Cambridges handbooks in construction robotics). Cambridge University Press. Dinwiddie, K. (2016). Basic robotics. Boston, MA: Cengage Learning. Siciliano, B., & Khatib, O. (2016). Springer Handbook of Robotics (2nd ed., Springer Handbooks). Cham: Springer International Publishing AG.

Subject Description Form

Subject Code	BRE537
Subject Title	Machine Learning and Data Mining for Construction
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	The overall objective of this course is to provide students with hands-on and fundamental knowledge of machine learning and data mining techniques to solve problems of modern construction projects and to carry out data analytics in construction. Specifically, this subject aims at: • Introducing the principles, concepts and models of modern machine learning and data mining. • Practicing the analytics skills to analyze data from construction areas and gain insight into it. • Understanding the practical applications of machine learning and data mining techniques in the construction industry.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) Understand the essential concepts of machine learning and data mining models and algorithms. (b) Use machine learning tools to develop data analytics solutions for solving real-world problems in construction projects. (c) Apply various supervised and unsupervised machine learning models to gain insight into various kinds of data arising from modern construction projects. (d) Understand the fundamental knowledge of data mining in collecting, organizing, summarizing, presenting, and analyzing data and drawing valid conclusions.
Subject Synopsis/ Indicative Syllabus	**Fundamental of machine learning and data mining (7 weeks)** • Data, Database & Data Warehouse, and Data Analytics: Defining data requirements, collecting data, cleaning data, storing data, processing data, analyzing data, and visualizing data. • Association Rule Mining: Apriori algorithm, interestingness measures, applications. • Supervised Learning: Classification and Regression Tree (CART), kNN, etc. • Deep Supervised Learning: Neural Networks (NN) and Convolutional Neural Networks (CNN) • Unsupervised Learning: k-means clustering and spatial clustering

- Deep Unsupervised Learning: dimensionality reduction, Autoencoder.
- Machine Learning and Data Mining Tools: TensorFlow, Pytorch, etc.

Applications of Machine Learning and Data Mining in Construction (6 weeks)

- Prediction and design of construction materials performance by machine learning and data mining
- The applications of machine learning on architectural design.
- Machine learning and data mining tools in 3D concrete printing.
- Manging the construction life-cycle activities using machine learning and data mining.
- Occupational health and safety monitoring.
- Damage prognosis: health monitoring of civil infrastructures.
- Building energy consumption analysis, prediction, and optimisation

Teaching/Learning Methodology

Lectures teach students on the main concepts of the course, together with comprehensive examples, and class questions and answers for easy understanding.

Tutorials help students to review the learned concepts, master the practical techniques and necessary tools for effective system/application development.

Labs and group project projects focused on analytics problems faced by cities, infrastructure, and environment, and offers the opportunity to students to develop analytical and problem-solving skills through system implementation and interpersonal communication.

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		
1. Continuous assignment*	55%	✓	✓	✓	✓		
a. Project	20%	✓	✓	✓	✓		
b. Assignments	20%	✓	✓	✓	✓		
c. Lab works	15%	✓	✓	✓	✓		
2. Examination*	45%	✓	✓	✓	✓		
Total	100 %						

	*Students are required to pass both the continuous assessment and examination to pass the subject. Continuous assessments consist of projects, assignments, and laboratory works, which are designed to facilitate students to achieve intended learning outcomes. Assignments are designed to ensure the students understand the concepts. The project is to enhance students' ability to acquire the understanding and using different knowledge, principles, techniques, tools to solve a real problem through team. Lab works are to ensure the students gain hands-on experience from machine learning tools. Examination will evaluate student's understanding and usage of machine learning and data mining techniques in construction.
Reading List and References	1. Jake VanderPlas, Python Data Science Handbook, O'Reilly Media, 2016. 2. Aurélien Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O'Reilly Media, 2019. 3. Jared Dean, Big Data, Data Mining, and Machine Learning: Value Creation for Business Leaders and Practitioners. Wiley, 2014. 4. EMC Education Services (Editor), Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data, Wiley, 2015. 5. Leskovec, Rajaraman, Ullman, Mining of Massive Datasets, 2nd Ed., Cambridge University Press, 2014. 6. Jiawel Han and Micheline Kamber, Data Mining: Concepts and Techniques. Morgan Kaufmann Publishers, 2012. 7. I. Goodfellow, Y. Bengio and A. Courville, Deep Learning, MIT Press, 2016. 8. Scikit-learn Machine Learning in Python https://scikit-learn.org/

Subject Description Form

Subject Code	BRE538
Subject Title	3D Printing in Construction: Principles and Applications
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	The objectives of this subject are: **1.** Equips students with an understanding of 3D printing, and how the technology works with different construction materials and their related applications in the construction sector. **2.** Develop strong competencies of students in advanced construction materials in 3D printing, digital design, and fabrication, enabling them to take leading positions in the field of architecture, construction, innovation development, and production management.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) Understand the technical principles and workflows for 3D printing of various construction materials, including metals, polymers, composites, etc. (b) Learn how to select a 3D printing process and material for a specific application in the construction sector. (c) Design structure for 3D printing by combining process knowledge, computational design tools, and application requirements. (d) Understand cutting-edge perspective on digital transformation and the factory of the future.
Subject Synopsis/ Indicative Syllabus	**1. Introduction and Basic Principles of 3D Printing** • Recap the conventional construction methods, including cast in situ, precast, spray concrete, etc. • Introduction to the generic process of 3D printing. • Compare the distinction between conventional construction methods and 3D printing • Case study: Analyse the benefits of 3D printing in construction with real examples. **2. 3D printing of Metals, Polymers, Glass and Clay**

	• Introduction to the 3D printing with metals, polymers, glass and clay, including printing process, material selection & modelling, quality control, and post processing. • Take real examples as case study for further explain their related applications in construction sector. **3. Extrusion-based 3D concrete printing** • Introduction to the classification of extrusion-based 3D concrete printing, including gantry system and robotic system. • Introduction to a general process of extrusion-based 3D printing, from equipment setup, material section, 3D CAD modelling to the final printing process. System concept on the extrusion-based 3D concrete printing. • Functional nozzle design, including current existing designed functional nozzle and basic operation of 3D CAD software. **4. Printable Material Design & Reinforcement** • Printable material selection, including material ingredients' effects, material constitutive model, and mixture design method. • Chemical additives' effects on the printable material hydration, fresh and hardened performance, and their applications in the material design of 3D concrete printing. • Material modelling, including buildability model, pumpability model, extrudability model, rheo-mechanical model. • Introduction to the function printable material, including printable strain-hardening construction material, printable transparent construction material, printable lightweight/sustainable material, etc. • Introduction to the method to introduce the reinforcement in the printed structures/materials. **5. Testing Methods & Quality Control in 3D Concrete Printing** • Recap conventional testing methods of construction materials/structures. • Introduction to the developed method in 3D concrete printing for the material and/or structural testing. • Recap the conventional quality control methods of construction materials/structures. • Introduction to the developed method in 3D concrete printing for the material and/or structural testing by digital technologies, including computer vision, machine learning, etc. **6. Particle-bed binding & Material jetting** • Introduction to the general process of particle-bed binding & material jetting

	• Raw material ingredients' selection and mixture design for these two processes. Systematic concept on the material modelling. • Factors impacting on the final printed structures and the underlaying mechanism will be introduced **7. Computational Method of 3D Printing in Construction** • Introduction to dynamo and grasshopper and their basic operation methods in the parametric structural design. • Basic programming skills. The students will gradually build up skills from the fundamental concepts to programming skills, including procedural, imperative, and functional programming (Python, Dynamo, Grasshopper etc.) **8. Applications of 3D Printing in Construction & Other Digital Construction Methods** • Take several practical examples to explain the potential applications of 3D concrete printing, including the 3D printed bridge in the Netherland, the 3D printed choreography in Switzerland, the 3D printed Bathroom Unit in Singapore, and the 3D printed green buildings in China. • Introduction to other digital construction methods, including mesh mould, smart dynamic casting, spatial timber assemblies, in situ robot fabrication, laser melting, spray-based 3D printing, etc.
Teaching/Learning Methodology	**1.** Lectures teach students on the main concepts of the course, together with comprehensive examples and class questions and answers for easy understanding. **2.** Laboratory tour with a concrete printing demonstration to help students build an overview of the real concrete printing process. **3.** Tutorial sessions help students review the learned concepts and master the practical techniques and necessary tools for effective system/application development. **4.** Group project offers the opportunity to students to develop analytical and problem-solving skills through system implementation and interpersonal communication.

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		
1. Project*	40%	✓	✓	✓	✓		
2. Presentation*	40%	✓	✓	✓	✓		
3. Quiz*	20%	✓	✓	✓			
Total	100 %						

*Students are required to pass all the specific assessment methods/tasks to pass the subject.

Continuous assessments consist of project, presentation and quizzes, are designed to facilitate students to achieve intended learning outcomes.

The project is designed to enhance students' ability to understand and use different knowledge, principles, techniques, and tools to design a structure and print through team.

Quizzes are to ensure the students understand the concepts and will comprise multiple-choice and short answer questions on 3D printing in construction, including printing process, printable materials, chemical additives, testing method and quality control, etc.

Reading List and References

1. Jay Sanjayan Ali Nazari Behzad Nematollahi, 3D Concrete Printing Technology, First Edition, Butterworth-Heinemann, 2019
2. Chee Kai Chua and Kah Fai Leong, 3D Printing and Additive Manufacturing - Principles and Applications, The Fifth Edition of Rapid Prototyping: Principles and Applications World Scientific Publishing Co., 2017.
3. Victoria Zukas and Jonas A. Zukas, An Introduction to 3D Printing, First Edition Design Publishing, Inc., 2015.
4. Bachman, David. Grasshopper: Visual Scripting for Rhinoceros 3D. Industrial Press, 2017.
5. Jabi, Wassim. Parametric design for architecture. Hachette UK, 2013.
6. https://compas.dev/

Subject Description Form

Subject Code	BRE586
Subject Title	Construction Information Technology
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	The objectives of this subject focus towards the application of IT in construction with emphasis on construction project management, construction information modeling and information technology service management.
Intended Learning Outcomes	By the end of this subject, participants should be able to: a. understand the ways of construction management workflow and dataflow analyses for the implementation of integrated construction management systems; b. understand the state of art of the information technologies and their applications in construction; c. understand the importance of disruptive technologies and information technology service management.
Subject Synopsis/ Indicative Syllabus	Unit 1. Construction Integrated Management System - Site Management. Unit 2. Construction Integrated Management System - Web-based PM and WPIS. Unit 3. BIM concept and applications. Unit 4. BIM and construction virtual prototyping technology. Unit 5. Case studies of using BIM and Construction Virtual Prototyping technology. Unit 6. Internet Technology and its Application to Construction. Unit 7. Database applications; Information Technology Service Management.

Teaching/Learning Methodology	• Lectures and seminars
	• Independent study
	  • Assignments
	  • Case study
	  • Self-study
	  • Computing

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.			
1. Assignment*	50%	√	√	√			
2. Examination*	50%	√	√	√			
Total	100%						

*Students are required to pass all the specific assessment methods/tasks to pass the subject.

Assignment requires students to work individually and submit an individual report that is focused on topics of IT applications on construction projects.

Examination will test students' understanding of fundamental knowledge of the application of IT in construction with emphasis on construction project management, construction information modeling and information technology service.

Reading List and References

ASCE Journal of Computing in Civil Engineering. *www.asce.org*.

Automation in Construction. An International Research Journal. *www.elsevier.com/locate/autocon*.

CIC, Construction Industry Council (2014), Roadmap for Building Information Modelling in Hong Kong's Construction Industry.

CIC, Construction Industry Council (2015), CIC Building Information Modelling Standards (Phase One) September 2015.

Electronic Journal of Information Technology in Construction, *www.itcon.org*.

Abid N, Wong K.D, Wong K.W "Bill of Quantities with 3D Views Using Building Information Modeling" in April 2015. Arabian Journal for Science and Engineering DOI 10. 1007/s13369-015-1657-2, ISSN 1319-8025.

Wong K.D. (2010) "*Attributes of Building Information Modelling Implementation in Various Country*" Journal of Architectural Engineering and Design Management", Special Issue in Integrated Design and Delivery Solutions, Page 288 to 302, Volume 6(4), November 2010, ISBN 978-1-84971-275-0.

Wong K.D. (2003) *Construction Integrated Management System for Contractors*, Journal of Building and Construction Management, Volume 8, Number 1, 2003, ISSN 102419540, pp. 12-18.

Wong K.D. (2013), "*Implementation of web-based construction project management system in China projects by Hong Kong developers*", Journal of Construction Innovation: Information, Process, Management, Jan 2013, Vol. 13 DOI/10.1108/14714171311296048 pp. 26 – 49.

Wong K.D. (2006), "*Use of Smart Card for Enhancing Construction Site Human Resources Management*" Journal of Building and Construction Management. Page 63 Volume 10 Number 1 2006 ISSN 102419540.

Subject Description Form

Subject Code	BRE587
Subject Title	Research Methods for Construction and Real Estate
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Mutually exclusive with MM501
Objectives	To meet the need of those who wish to contribute to the identification of business and project problems, to select appropriate techniques for their solution and to present and communicate their findings in a logical way.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. define research and distinguish between research and other forms of enquiry; b. describe the features of the scientific method and to apply them to problems in construction and property; c. properly define and undertake a specific problem orientated research; d. formulate questions in a way which renders them amenable to rigorous investigation; e. know where and how to search for literature/information for research and consultancy work; f. assess the usefulness of research methods for particular problems using as criteria the hallmarks of good research; g. identify, collect, analyse and present information appropriate to finding a solution to the problem; h. describe broadly the strengths and limitations of basic approaches to qualitative and quantitative research; i. effectively communicate the findings of their work orally and in written form.
Subject Synopsis/ Indicative Syllabus	• Introduction to research methodologies • Formulation of a research problem • Library session on information management • Guest speakers on consultancy strategies and tactics; • Research methods in construction management

	• Qualitative and quantitative data analysisPreparation of research proposal and research paper • Dissertation writing •
Teaching/Learning Methodology	Students are required to attend the seminars presented by guest speakers. They are also required to attend the library workshop and complete a quiz administered by the Faculty Librarian of the University Library. There will be a take-home assignment in the form of a case study report. Students are required to set assumptions, collect data, decide the test methods and draw conclusions from the results. Students are also required to present the research proposal and research findings in class.
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	f	g	h	i	
1. Take-home assignment: write research proposal	40%	✓	✓	✓	✓	✓	✓				
2. Take-home assignment: report research findings	40%					✓	✓	✓	✓	✓	
3. Oral presentation for research proposal	10%	✓	✓	✓	✓	✓	✓				
4. Oral presentation for research paper	10%					✓	✓	✓	✓	✓	
Total (Continuous Assessment*)	100%										

*Students are required to achieve grade D or above in overall subject grade to pass the subject.

Writing research proposal will develop students' academic skill in the preparation of a research proposal for a chosen topic.

Reporting research findings will develop students' academic skill in the presentation of research findings using appropriate research methods.

	Oral presentation will develop students' presentation skills, and practice their summarizing skills
Reading List and References	**Recommended Readings:** Bell, J. and Waters, S. (2018). *Doing your Research Project*. A Guide for First-time Researchers, 7th Edition, Open University Press, London. Fellows, R. and Liu, A. (2015). *Research Methods for Construction.* 4th Edition, Blackwell, Wiley. Pallant, J. (2010) SPSS survival manual: a step by step guide to data analysis using SPSS, 4th Edition, Open University Press/McGraw-Hill, Maidenhead. Rowntree, D. (2000). *Statistics Without Tears: An Introduction for Non-Mathematicians*, Penguin Science.

Subject Description Form

Subject Code	BRE5751
Subject Title	Strategic Management
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil
Objectives	a. To provide students with in-depth understanding of the subjects relating to strategy and strategic management. b. To develop the students' ability in applying strategic management theories and techniques in practice in the area of construction and real estate.
Intended Learning Outcomes *(Note 1)*	Upon completion of the subject, students will be able to: a. understand strategy and strategic management; b. possess knowledge in strategic management techniques throughout the development and project cycle; c. apply theories and techniques in practice in the area of strategic management.
Subject Synopsis/ Indicative Syllabus *(Note 2)*	Strategy & strategic management Organization competitiveness Eastern theories on strategy Strategy in a changing world; strategy & leadership Systems Approach to strategic management Tactics and SWOTE Analysis Strategic management in practice; strategy tools Designing organizations and strategies Sustainable development; Sustainability principle, environmental impact, environmental performance assessment and protection. Challenges of major programme management Strategic management in construction; project management: strategic time, cost & quality management Corporate strategy and real estate Risk management, Risk concept, principles of the management of risks, risk management techniques, risk attitude, decision making and application of risk management Quality management, quality management system (QMS)

Teaching/Learning Methodology *(Note 3)*	Topics are introduced through a study guide and recommended texts supplemented by materials delivered through lectures and seminars. The independent study comprises individual and group work as well as cases for tutorials. Students are part of small study groups who use face-to-face or web-based media to share views and interact with group members. • Face-to-face teaching & learning: Lectures, Tutorials, Seminars and Discussion • Independent study: Assignments (Individual Report) and Guided-study (Cases for discussion and presentation at tutorials)
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			
1. Continuous Assessments*	50%	√		√			
• Individual Report	40%						
• In-class participation	10%						
2. Examination*	50%		√	√			
Total	100 %						

*Students are required to pass both the continuous assessment and examination to pass the subject.

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Students are required to submit a Term Paper and to demonstrate the ability to apply theory and techniques in practice.

In examination, students are required:

- to demonstrate knowledge in strategic management techniques throughout the development and project cycle;
- to apply theories and techniques in practice in the area of strategic management.

Reading List and References

Recommended readings:

Evans V (2014) *Strategy Tools* FT Publishing, Pearson

Galbraith J (2014) *Designing Organizations* Jossey-bass, Wiley

	Harvard Business Review *HBR's Must-Reads on Strategy* (Article Collection: Product 12601) Langford D and Male S (2001) *Strategic Management in Construction* Blackwell Science, Oxford Shen, L.Y. Lu W.S and Fan L.C.N. (2009). *Strategic Management*, The Hong Kong Polytechnic University. Sun Tze *The Art of War* (Chinese &/or English Translations) Weatherhead M. (1997) *Real Estate in Corporate Strategy* MacMillan ***<u>Selected journal and conference papers</u>*** CIOB (2014) *"Strategy"* in *Code of Practice for Project Management for Construction and Development* 5th ed. (85-110) John Wiley & Sons. Flanagan, R., Lu, W.S., Shen, L.Y. and Jewell, C. (2007). *Competitiveness in Construction: A Critical Review of Research, Construction Management and Economics*, Vol. 25, 989-1000. Shen L.Y. (1999). 'Risk Management', Building in Value: Pre-design Issues, (Ed., Best & De Valence) Arnold Publishers, ISBN: 0340741600, pp.248-267.