Faculty of Construction and Environment

Research Postgraduate Programme Requirement Document 2023/24

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

FACULTY OF CONSTRUCTION AND ENVIRONMENT
建設及環境學院

Opening Minds • Shaping the Future • 啟迪思維 • 成就未來

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This Document is subject to review and changes which the programmes offering Faculty/Department can decide to make from time to time. Students will be informed of the changes as and when appropriate. This Document should be read together with the Guidelines and Regulations for Research Postgraduate Studies and the Research Postgraduate Student Handbook.

Part I

General

1. Introduction

The Faculty of Construction and Environment (FCE), to achieve its mission “to meet the needs of infrastructure development and environmental conservation in Hong Kong, the Chinese mainland and beyond”, offers a broad range of international competitive academic programmes and conducts world-class high-impact interdisciplinary research in construction, environment, energy, urban hazard mitigation, urban informatics towards sustainable urban development and smart city.

FCE provides numerous programmes for studies leading to the Doctor of Philosophy (PhD) or Master of Philosophy (MPhil) degrees. Research students are nurtured to become scholars, researchers, and entrepreneurs who can ***demonstrate research and scholarship excellence, conduct independent and original research,*** and ***engage in lifelong learning.***

Our Research Postgraduate (RPg) Programmes are designed to facilitate the competence development in research methods and scholarships. Students are encourage to display sustained effort and independent original thought for high-impact interdisciplinary research. The Faculty also strives to develop entrepreneurial competencies in students by promoting the exchange of inventive ideas and entrepreneurial experiences.

MPhil and PhD students are required to satisfactorily investigate or evaluate a chosen area, to show understanding of the context and significance of the work, and to present a compelling thesis worthy of publication. Furthermore, PhD students are expected to produce evidence and arguments to support an original proposition that represents a significant contribution to knowledge.

The degree of PhD or MPhil shall be awarded to a student who, on completion of an approved programme and fulfilling the coursework requirements for graduation, presents a thesis embodying the results of his/her research and satisfies the examiners in an oral examination (and other examinations if required) in matters relevant to the subject of the thesis.

2. Educational Aims and Institutional Learning Outcomes

Built on the strength of its research in sustainable urban development, the Faculty's diversified postgraduate programmes aim to make the world a better place by engaging in multidisciplinary research. On completion of their postgraduate degrees, students are expected to be able to demonstrate research and scholarship excellence, originality, and lifelong learning capability.

2.1 Research and Scholarship Excellence

MPhil graduates of PolyU should demonstrate advanced competence in research methods, with the ability to apply their knowledge to analyse and solve identified issues and problems in their areas of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.

PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their areas of study, possess superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.

2.2 Originality

MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their areas of study.

PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create new original solutions to issues and problems pertaining to their areas of expertise and the society in general.

2.3 Lifelong Learning Capability

MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their areas of study.

PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their areas of study.

3. Mode of Study and Duration

3.1 Academic Year

There are two teaching semesters, each lasting for 13 weeks, and a 7-week summer term. The teaching of Semester One starts in late August or early September. The teaching of Semester Two commences in mid-January and that of Summer Term runs from May to July.

3.2 Mode of Study and Duration

The following table shows the normal and maximum periods of study for various research degree programmes. Students enrolled for Dual PhD Degree Programmes please refer to Section 9 for details.

Degree	Study Mode	Normal Study Period	Maximum Study Period
PhD	Full-time	3 years*	5 years*
		4 years#	6 years#
	Part-time	6 years*	7 years*
		8 years#	9 years#
MPhil	Full-time	2 years	3 years
	Part-time	4 years	5 years

* *for PhD students admitted on the basis of an MPhil or equivalent*

\# *for PhD students admitted on the basis of a Bachelor's degree with First Class Honours (or equivalent qualification), OR a Master's degree*

If an RPg student is unable to complete his/her study within the normal study period, he/she shall notify the DRC Chair via the Chief Supervisor in writing before the normal study period expires, indicating the reasons and the expected completion date, which should fall within the maximum period of study. The DRC Chair shall act on the Chief Supervisor's recommendations to approve or disapprove the RPg student's request for continuing his/her studies beyond the normal period of study (but within the maximum period of study), and inform the DGO or the GS of his/her decision.

4. Admission

4.1 Admission Requirements

To register for the degree of MPhil, a student shall hold a Bachelor's degree with Second Class Honours or above (or equivalent qualification) conferred by a recognised university

To register for the degree of PhD (3-year full-time / 6-year part-time), a student shall normally hold an MPhil or equivalent (a research postgraduate degree with a dissertation as an award requirement) conferred by a recognised university.

To register for the degree of PhD (4-year full-time / 8-year part-time), a student shall normally hold a Master's degree; OR a Bachelor's degree with First Class Honours (or equivalent qualification), conferred by a recognised university.

PolyU may accept other equivalent qualifications. The decision is made on an individual basis.

4.2 English Language Requirements

The requirements for those who do not have a degree for which English was the language of instruction at a recognised university are:

- An overall score of at least 6.5 in the International English Language Testing System (IELTS); OR
- A Test of English as a Foreign Language (TOEFL) score of 80 or above for the Internet-based test.

All English language test scores are considered valid for two years after the date of the test.

4.3 Research Proposal & Supervisory Arrangements

Each RPg student registered for PolyU's RPg programme shall follow an approved programme of research and coursework under a Chief Supervisor and Co-supervisors, if appropriate. With a view to providing both departments and newly-admitted RPg students opportunities to identify the most appropriate supervisors, the DRC shall follow one of the following supervisory arrangements:

- For RPg student admitted with a detailed research proposal and a proposed Chief

Supervisor and one/more/no Co-supervisors, the DRC shall (i) assign a Chief Supervisor (ii) assign one/more Co-supervisors as appropriate, and (iii) approves the student's research proposal when making the admission decision.

- For RPg student is admitted without being assigned a Chief Supervisor and without an approved research project at the point of admission, i.e., on the first day of his/her affiliation with the Department, the Department is obliged to assign the most suitable staff member(s) as supervisor(s) within four months of admission, and the RPg student and his/her supervisor(s) are required to formulate a research proposal for the DRC's approval within four months of admission.

Please refer to the *Research Postgraduate Student Handbook* from the Graduate School (GS) for a clear statement of the roles and responsibilities of the various parties involved in research supervision. [1]

4.4 Application Procedures

The main application deadline for PolyU research postgraduate programme is 31 May each year. Applicants should submit an online application and settle the application fee before the application deadline via the Academic Registry (AR)'s eAdmission System.

The Hong Kong PhD Fellowship Scheme (HKPFS), established by the Hong Kong Research Grants Council (RGC), calls for applications around September each year. To apply for HKPFS via PolyU, applicants should file an initial application to the RGC via the HKPFS Electronic System to obtain a reference number. Applicants must quote the HKPFS reference number allocated by the RGC in their applications to PolyU.

Applicants may log-in to the AR's eAdmission System to check their application status (e.g., notification of interview/test and admission offer) at any time.

Please refer to *"Importance Notes to Applicants"* under *"e-prospectus"* for Research Postgraduate for detailed application information and procedures. [2]

5. Registration and Progress

For research students, each academic year is divided into three equal semesters and term (i.e. 4 months for each semester/term) as follows:

Semester One	Semester Two	Summer Term
1 September to 31 December	1 January to 30 April	1 May to 31 August

Students are required to commence their study at PolyU and report study commencement at the General Office of the host department with the schedule as follows:

Semester One	Semester Two	Summer Term
1 September or 1st day of the semester, whichever is earlier	1st working day after 1 January	1st working day after 1 May

5.1 Confirmation of Registration

An RPg student is regarded as provisionally registered under a FT or PT RPg programme before the Confirmation of Registration is completed. Subject to a formal assessment an RPg student is required to have his/her registration confirmed before the deadline as stipulated below:

<table>
<tr><th rowspan="2">Study Mode</th><th rowspan="2">Programme</th><th rowspan="2">Normal Period of Study (years)</th><th colspan="2">Deadlines for Confirmation of Registration</th></tr>
<tr><th>For RPg students admitted from the 2017/18 cohort</th><th>For RPg students admitted in or before the 2016/17 cohort</th></tr>
<tr><td rowspan="5">FT</td><td rowspan="2">PhD</td><td>4</td><td>At the end of the first 6 semesters/terms</td><td>At the end of the first 24 months</td></tr>
<tr><td>3</td><td>At the end of the first 5 semesters/terms</td><td>At the end of the first 18 months</td></tr>
<tr><td>Collaborative PhD Training Programme</td><td colspan="3" rowspan="2">See Research Postgraduate Student Handbook – Appendix 1</td></tr>
<tr><td>Joint PhD</td></tr>
<tr><td>MPhil</td><td>2</td><td>At the end of the first 3 semesters/terms</td><td>At the end of the first 12 months</td></tr>
<tr><td rowspan="2">PT</td><td rowspan="2">PhD</td><td>8</td><td>At the end of the first 12 semesters/terms</td><td>At the end of the first 48 months</td></tr>
<tr><td>6</td><td>At the end of the first 9 semesters/terms</td><td>At the end of the first 36 months</td></tr>
</table>

	MPhil	4	At the end of the first 6 semesters/terms	At the end of the first 24 months

Remarks: Some academic departments may set earlier deadlines for Confirmation of Registration for their RPg students. RPg students should check with their DGO for details

RPg students failing to have their registration confirmed by the deadlines or the approved extended deadlines will be de-registered from the RPg programme immediately. [1]

5.2 Progress Monitoring

An RPg student should ensure there is a clear understanding of the communication mechanisms and the frequency of research guidance meetings with the supervisor (usually meetings are more frequent at the start and near completion of the research programme).

All RPg students will be assessed by their academic department annually. Each RPg student is required to submit a progress report and will be allowed to proceed on with his/her studies subject to satisfactory performance as judged by DRC. [1]

5.3 Deregistration

An RPg student will be de-registered from his/her studies at PolyU on grounds of academic failure in the following circumstances:

- if his/her progress is considered unsatisfactory; or
- if he/she fails to complete the Confirmation of Registration before the deadline; or
- if he/she fails to submit the thesis upon the expiry of the maximum period of study; or
- if his/her thesis is deemed unsatisfactory.

A recommendation for deregistration as a result of unsatisfactory progress may be proposed by the Chief Supervisor and approved by the DRC. The DRC Chairman cannot take action by himself/herself on this issue.

A recommendation for deregistration as a result of unsatisfactory thesis made by the Board of Examiners (BoE) shall be approved or rejected by the Graduate School Board (GSB).

6. Requirements of Graduation

Students should meet the following requirements before they can be considered for graduation:

6.1 English Enhancement Subjects and Research Language Skills Assessment

For research students admitted in the 2017/18 cohort or before, all research students are required to take the Research Language Skills Assessment (RLSA). They shall approach the Graduate School (GS) for advice and subject enrolment.

For students admitted between 2018/19 and 2020/21 cohorts, all research students are required to take and pass two mandatory English subjects, ELC6001 *"Presentation Skills for Research Students"* and ELC6002 *"Thesis Writing for Research Students"* before their thesis submission. For exemption, RPg students need to pass the Research Language Skills Assessment (RLSA).

For students admitted from the 2021/22 cohort onwards, all research students are required to take the Research Language Skills Assessment (RLSA). Student's performance on the test will determine if they need to complete the University's English Enhancement Subjects and which subject(s) they should take. All English Enhancement Subjects (ELC6011, ELC6012 and ENGL6016) are credit-bearing.

6.2 Coursework/Credit Requirements

6.2.1 University Coursework Requirements

All RPg students are required to complete the coursework/credit requirements before thesis submission. Subjects are chosen by the student, with advice from the Chief Supervisor. The University coursework/credit requirements are:

Programme	**Credit requirement**	**Details**	
		RPg students admitted in or after the 2023/24 Cohort	***RPg students admitted in or before the 2022/23 Cohort***
2-year full-time/ 4-year part-time MPhil	9 credits	- 1 credit from HTI6081* - 2 credits from attending seminars - 6 credits from Faculty compulsory and other elective subjects	- 1 credit from HTI6081* - 2 credits from attending seminars - 6 credits from Faculty compulsory subjects

3-year full-time/ 6-year part-time PhD	15 credits	- 1 credit from HTI6081* - 3 credits from attending seminars - 2 credits from Practicum - 9 credits from Faculty compulsory and other elective subjects	- 1 credit from HTI6081* - 3 credits from attending seminars - 2 credits from Practicum - 9 credits from Faculty compulsory and other elective subjects
4-year full-time/ 8-year part-time PhD	22 credits	- 1 credit from HTI6081* - 4 credits from attending seminars - 2 credits from Practicum - 15 credits from Faculty compulsory and other elective subjects	- 1 credit from HTI6081* - 4 credits from attending seminars - 2 credits from Practicum - 15 credits from Faculty compulsory and other elective subjects
- RPg students admitted from the 2021/22 Cohort onwards are required to complete 0 to 5 credits from English Enhancement Subjects in addition to the credit requirement stipulated above. - RPg students admitted from the 2022/23 Cohort onwards are required to complete a non-credit bearing e-module on "Understanding China and the Hong Kong Special Administrative Region, P.R.C." and pass the assessment.			

**HTI6081 is a University compulsory 1-credit subject entitled "Ethics: Research, Professional and Personal Perspectives".*

6.2.2 Faculty Compulsory and Elective Subjects

Research students of FCE are required to complete the Faculty compulsory subjects listed below before thesis submission:

RPg students from the 2023/24 Cohort	RPg students admitted in or before the 2022/23 Cohort
• *CE603 Research Frontiers in Construction and Environment* (3 credits)	• *CE603 Research Frontiers in Construction and Environment* (3 credits) • *CE620 Research Methods* (3 credits)

Subject to the advice and approval of the Chief Supervisor, students may enroll in subjects offered by the Faculty, by its own departments, by sister departments of PolyU and/or by other universities in Hong Kong, in order to fulfill the credit requirements.

All FCE guided-study subjects were removed *en bloc* from the programme curricula from the 2018/19 academic year.

6.2.3 Practicum

To earn one credit for practicum, students will be required to engage in teaching activities/professional service assigned by the Head of Department (HoD) or his/her delegate for 6 hours/week in any 13-week semester. They can choose to

complete these two credits in two different semesters or within the same semester, subject to the approval of the Chief Supervisor. Stipend recipients are not allowed to fulfill part of their departmental training requirement through the completion of these compulsory training credits.

Students who are required to undertake teaching supporting activities are required to complete the training programmes organised by the Educational Development Centre, English Language Centre/Chinese Language Centre (as required) before the commencement of any teaching supporting activities.

6.2.4 Attendance at Seminars

All Full-time RPg students are required to attend at least 10 research seminars per year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year.

All Part-time RPg students are required to attend at least 10 research seminars per two years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two years.

RPg students are recommended to complete one credit per year (for FT students) or per two years (for PT students) to fulfill the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for FT students) or per two years (for PT students) to fulfill the research seminar credit requirement.

Please refer to *Research Postgraduate Student Handbook* for detailed requirements [1]

6.2.5 Credit Transfer

Applications for the transfer of credits from recognised previous studies will be endorsed by the DRC with justifications and approved by the HoD. Only credit gained from subjects at postgraduate level that have not been used to contribute to an award will be acceptable for transfer.

For RPg students admitted between the 2014/15 and 2017/18 cohorts, the validity period for such credit transfer for research degree programmes is defined to be five years from the year of attainment at the time of admission.

For RPg students admitted from the 2018/19 cohort onwards, the validity period for such credit transfer for research degree programmes is defined to be eight years from the year of attainment at the time of admission. The maximum number of credits transferrable is no more than 50% of the credit requirement of the programme disregarding whether the credits were earned within or outside PolyU.

6.2.6 Subject Exemption

An RPg student may apply for exemption from taking a compulsory subject if he/she has successfully completed a similar subject previously in another programme or already has the associated knowledge/skills via work experience, etc. The application should be considered and approved by the DRC. If an RPg student is exempted from taking a compulsory subject, the credits associated with the exempted subject will not count towards the credit requirements. It will therefore be necessary for the student to take another subject, to be approved by the Chief Supervisor, in order to satisfy the credit requirements.

For regulations and procedures governing the credit transfer and subject exemption, please refer to the *Research Postgraduate Student Handbook*. [1]

6.2.7 Qualify GPA Requirements

All RPg students need to complete their coursework with a qualifying GPA of 2.7 or above before submission of their thesis to the relevant offices for oral examination. They may take more subjects than required in order to improve their GPA or in order to strengthen their knowledge. However, subjects taken after thesis submission will not contribute to the qualifying GPA.

6.3 Residence Requirement

Residence provides students with an opportunity to become immersed in the intellectual environment of the University. Residence also includes periods during which students' research requires off-campus field or non-PolyU laboratory work approved by the host department. The residence requirements for the MPhil/PhD Programmes are as follows:

Programme	**Residence Requirement**
2-year FT / 4-year PT MPhil programme	2 regular semesters
3-year FT / 6-year PT PhD programme	3 regular semesters
4-year FT / 8-year PT PhD programme	4 regular semesters

All RPg students must fulfill the residence requirement before thesis submission [1]

In addition to the residence requirement, full-time RPg students are required to be on campus full-time and consequently in such geographical proximity as to be able to participate fully in PolyU activities associated with the RPg programme.

6.4 Thesis Requirements

On completion of an approved programme of study and research, an RPg student must submit a thesis to PolyU (which must be before the end of his/her maximum period of study) and defend it in an oral examination. If an RPg student is unable to complete his/her study within the normal study period, he/she shall apply for continuing his/her studies beyond the normal period of study (but within the maximum period of study) for the DRC Chair's approval. Any RPg student who fails to submit his/her thesis to the relevant offices* by the end of the normal period of study is required to pay a continuation fee regardless of whether or not he/she is receiving the Postgraduate Scholarship.

Research students of FCE need to complete their coursework with a stipulated qualifying GPA before they can submit the thesis for examination.

MPhil and PhD theses shall consist of the RPg student's own account of his/her investigations and be integrated and coherent piece of work. The thesis should be presented in English. Permission must be sought preferably at the point of admission, if another language, which is considered more appropriate to the subject, is to be used in the presentation of the thesis. Strong justifications on academic grounds must be provided to substantiate that the use of English will adversely affect the clarity of the thesis should another language be used. [1]

** The "relevance offices" refers to:*

Graduate School (GS) for RPg students admitted in or before the 2017/18 cohort

General Office of Department for RPg students admitted from 2018/19 cohort onwards

7. Award of Degree

The PhD or MPhil degree is awarded to an RPg student who completes all stipulated coursework requirements, presents a thesis embodying the results of his/her research and satisfies the examiners in an oral examination (and other examinations if required) in matters relevant to the subject of the thesis.

8. Financial Assistantship

8.1 Scholarships

PolyU offers different scholarship schemes including fellowships to eligible FT RPg students on the basis of academic merit. These fellowships and scholarships aim to allow the FT RPg students to fully focus on their studies. Since the awardees are FT RPg students instead of employees of PolyU, the fellowships and scholarships will not be subject to taxation.

Hong Kong PhD Fellowship Scheme (HKPFS)

The Scheme, established by the Hong Kong Research Grants Council (RGC), aims to attract the best brightest students in the world to pursue their PhD studies in Hong Kong. The Scheme calls for application in September each year. [3]

PolyU Presidential PhD Fellowship Scheme

The Scheme offers an attractive scholarship package and aims to attract outstanding PhD applicants to support their research studies at PolyU and living expenses in Hong Kong.

Postgraduate Scholarship

With effect from academic year 2021/22, the “Research Studentship” is re-named “Postgraduate Scholarship” which will be awarded by the respective DRC to eligible RPg students. The DRC will determine a period for which RPg students to receive a monthly stipend. Normally, the period for Scholarship will not exceed the normal period of study.

8.2 Associate Money and Conference Attendance Grant

RPg students admitted in or before the 2021/22 cohort, irrespective of the funding source, should be provided with Associated Money during the normal study period (with a reference amount of HK$20,000/year for full-time RPg students and HK$10,000/year for part-time students).

All RPg students, irrespective of funding source, should be provided with Conference Grant during their studies at PolyU. They are allowed to make use of the Conference Grant up to the date of oral examination. There is no restriction on the number of times an RPg student can be supported by Conference Grant for conference attendance, as long as the total amount of Conference Grant allocated to him/her throughout his/her studies does not exceed HK$25,000 (for awardees of the Hong Kong PhD Fellowship Scheme, the amount of conference grant is HK$13,800/year according to the regulations of the Scheme). A maximum amount of HK$20,000 can be granted for each application. The use of Conference Grant is now allowed after an RPg student has attended his/her oral examination.

9. Dual PhD Degree Programmes

The Programme refers to the joint offer of a PhD programme between PolyU and another institution of good standing. Upon satisfactory completion of study, the student will receive two award parchments issued each by PolyU and the partner institution.

Students admitted under these programmes should refer to *Research Postgraduate Student Handbook – Appendix 1* for specific regulations and administrative procedures. [1]

10. Research/Academic Attachment Opportunities

10.1 Research Student Attachment Programme

The programme provides an invaluable opportunity for full-time PhD students to add a global dimension to university life. Successful applicants will continue to receive the Postgraduate Scholarship, if applicable, while continuing their research interests in a non-local host institution.

The programme may range from a minimum of three months to a maximum of one year. Travel expenses and a monthly subsistence allowance will normally be supported, subject to the details announced during the two calls for applications issued each year in September/October and March/April.

11. References

[1] Research Postgraduate Student Handbook
https://www.polyu.edu.hk/gs/rpghandbook/

[2] Important Notes to Applicants, e-prospectus for Research Postgraduate
http://www51.polyu.edu.hk/eprospectus/rpg/important-notes-to-applicants

[3] Hong Kong PhD Fellowship Scheme (HKPFS)
https://www.polyu.edu.hk/gs/prospective-students/hkpfs/

Part II

FCE Research Postgraduate Programmes

Department of
***B**uilding **E**nvironment and*
***E**nergy **E**ngineering*

Department of Building Environment and Energy Engineering

1. Introduction

The Department of Building Environment and Energy Engineering (BEEE), originally named Building Services Engineering (BSE), was officially established in December 1981, and has become one of the largest BEEE departments worldwide. As a leading provider of trained professionals in building services for the unique environment of Hong Kong, research in BEEE focuses on enhancing the quality of the environment, energy efficiency, the use of renewable energy, and the safety and resilience of buildings to effectively address the contemporary concerns and future challenges of urban environments. Its core mission is to devise and improve engineering systems to promote the health and well-being of building occupants by providing a sanctuary from the elements and the extremes of temperature, noise, light, toxins and pathogens at the lowest cost of energy and resources. It offers a range of undergraduate and postgraduate degree programmes serving the needs of the local industry.

BEEE research is highly recognized among the most prestigious universities worldwide, being ranked 15 in both Architecture & Built Environment and Engineering (Civil and Structural Engineering) by the latest 2022 QS World University Rankings. The expertise of BEEE academic staff spans a wide range of disciplines, including the aspects of sustainability; building energy, heating, ventilation and air-conditioning systems; fire and safety engineering; electrical technology; public health; indoor environmental engineering; architectural engineering; computer-aided design and facilities management.

In recent years, the Department has made a remarkable achievement in securing highly competitive and prestigious multi-year, multimillion-dollar grants, including two from the Theme-based Research Scheme, one from the Research Impact Fund and three from the Collaborative Research Fund.

2. Aims and Learning Outcomes

The PhD and MPhil degree programmes aim to provide rigorous training to students who aspire to become researchers or scholars capable of conducting independent and original research, and producing research findings that are relevant and significant to their chosen field of specialisation. The objectives of the programme of study are to equip students with rigour and wit. To be awarded the degree, students must demonstrate their research competence by submitting a thesis and successfully defending it. This is to ensure that students have attained the appropriate/requisite standard and acquired ability to:

- fully understand and critically evaluate the literature related to their chosen area of study;
- identify problems of relevance and significance worthy of investigation;
- formulate the problems into testable pieces amenable to rigorous investigation;
- apply appropriate research methodology to conduct the investigation;
- perform careful and thorough analysis from which valid conclusions are drawn; and
- present the findings in a clear, lucid and cogent manner.

3. PhD/MPhil Programmes

- PhD Programme in Building and Environment
- MPhil Programme in Building and Environment

- PhD Programme in Building Energy
- MPhil Programme in Building Energy

- PhD Programme in Building Safety and Resilience
- MPhil Programme in Building Safety and Resilience

- PhD Programme in Electrical Services
- MPhil Programme in Electrical Services

- PhD Programme in Facility Management
- MPhil Programme in Facility Management

4. Intended Learning Outcomes and Curriculum Maps for Individual Programmes

4.1 PhD Programme in Building and Environment

4.1.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area 2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment

4.1.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II/III/IV	BSE6105-BSE6106* Practicum I/II	Thesis*
1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively	✓	✓	✓		✓	✓								✓		✓
3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓		✓
4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment	✓	✓	✓	✓		✓								✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.2 MPhil Programme in Building and Environment

4.2.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area 2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	4. To be able to engage in continual professional development through inquiry and reflection in the subject area

4.2.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II	Thesis*
1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively	✓	✓	✓		✓	✓								✓	✓
3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓	✓
4. To be able to engage in continual professional development through inquiry and reflection in the subject area	✓	✓	✓	✓		✓								✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.3 PhD Programme in Building Energy

4.3.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area 2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment

4.3.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II/III/IV	BSE6105-BSE6106* Practicum I/II	Thesis*
1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively	✓	✓	✓		✓	✓								✓		✓
3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓		✓
4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment	✓	✓	✓	✓		✓								✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.4 MPhil Programme in Building Energy

4.4.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area 2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	4. To be able to engage in continual professional development through inquiry and reflection in the subject area

4.4.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II	Thesis*
1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively	✓	✓	✓		✓	✓								✓	✓
3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓	✓
4. To be able to engage in continual professional development through inquiry and reflection in the subject area	✓	✓	✓	✓		✓								✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.5 PhD Programme in Building Safety and Resilience

4.5.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area 2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment

4.5.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II/III/IV	BSE6105-BSE6106* Practicum I/II	Thesis*
1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively	✓	✓	✓		✓	✓								✓		✓
3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓		✓
4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment	✓	✓	✓	✓		✓								✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.6 MPhil Programme in Building Safety and Resilience

4.6.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area 2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	4. To be able to engage in continual professional development through inquiry and reflection in the subject area

4.6.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II	Thesis*
1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively	✓	✓	✓		✓	✓								✓	✓
3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓	✓
4. To be able to engage in continual professional development through inquiry and reflection in the subject area	✓	✓	✓	✓		✓								✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.7 PhD Programme in Electrical Services

4.7.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area 2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment

4.7.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II/III/IV	BSE6105-BSE6106* Practicum I/II	Thesis*
1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively	✓	✓	✓		✓	✓								✓		✓
3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓		✓
4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment	✓	✓	✓	✓		✓								✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.8 MPhil Programme in Electrical Services

4.8.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area 2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	4. To be able to engage in continual professional development through inquiry and reflection in the subject area

4.8.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II	Thesis*
1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively	✓	✓	✓		✓	✓								✓	✓
3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓	✓
4. To be able to engage in continual professional development through inquiry and reflection in the subject area	✓	✓	✓	✓		✓								✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.9 PhD Programme in Facility Management

4.9.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area 2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment

4.9.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II/III/IV	BSE6105-BSE6106* Practicum I/II	Thesis*
1. To possess state-of-the-art expertise and knowledge in the area of study, and to be able to identify critical issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write high-quality technical documents about the research work and to disseminate/communicate the results and findings with other professionals effectively	✓	✓	✓		✓	✓								✓		✓
3. To carry out independent and original research with critical and creative thinking by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓		✓
4. To be able to engage in an enduring quest for knowledge and for continual academic/professional development in a dynamically changing environment	✓	✓	✓	✓		✓								✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.10 MPhil Programme in Facility Management

4.10.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area 2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	4. To be able to engage in continual professional development through inquiry and reflection in the subject area

4.10.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BSE6001 Computational Fluid Dynamics	BSE6004 Fire Science and Fire Safety Engineering	BSE6005 Indoor and Outdoor Environmental Quality Evaluation & Simulation	BSE6101-BSE6104* Research Seminar I/II	Thesis*
1. To possess advanced expertise and knowledge in the area of study, and to be able to identify issues or formulate problems in the subject area				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To write technical documents about the research work up to the professional standard, and to present the results and findings effectively	✓	✓	✓		✓	✓								✓	✓
3. To carry out independent research by developing effective research objectives, plan, and implement research work in a professional manner				✓		✓		✓	✓	✓				✓	✓
4. To be able to engage in continual professional development through inquiry and reflection in the subject area	✓	✓	✓	✓		✓								✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

Department of
***B**uilding and **R**eal **E**state*

Department of Building and Real Estate

1. Introduction

Since its foundation in 1937, the Department has become internationally recognised as a leader in providing professional education for the building and real estate industry in the region and beyond. With our dedication to excellence, we have a multi-disciplinary team of faculty members who possess expertise in their respective fields of surveying, engineering, construction health and safety, town planning, building technology, real estate, finance, law and economics. Committed to a variety of quality research projects and consultancies, we are well-known for our research strengths in construction and building technologies. To facilitate knowledge transfer and networking, we actively maintain strong bonds with the industry and our alumni, many of whom are senior staff in government departments leading consultancy practices and private enterprises.

Dedicated to fundamental and high impact research related to sustainable urban development in densely populated cities, the Department has identified three major focuses, namely: Construction Health and Safety, Digital Construction and Sustainable Urban Systems, which embrace the expertise of most of the staff members. Projects with significant societal impacts are encouraged and supported.

2. Aims and Learning Outcomes

The Research Postgraduate Programmes (PhD and MPhil) aim to train and nurture students to become researchers or scholars capable of conducting independent and original research, and producing significant research findings relevant to their chosen field of specialisation. The main objective of the programmes is to equip students with the knowledge, skills and abilities to conduct academic research work with rigour and integrity. To be awarded the degree, students must demonstrate their independent research competence by submitting a thesis and successfully defending it in an oral examination. This is to ensure that students have attained the required standard and are able to:

- critically evaluate the literature and acquire an in-depth understanding of their chosen area of study;
- identify scientific problems worthy of investigation;
- apply solid and appropriate research methods to conduct the investigation;
- carefully and thoroughly analyse the research findings to reach sound conclusions; and present the research findings in a clear and logical manner.

3. PhD/MPhil Programmes

- PhD Programme in Construction and Real Estate Economics
- MPhil Programme in Construction and Real Estate Economics

- PhD Programme in Construction and Real Estate Management
- MPhil Programme in Construction and Real Estate Management

- PhD Programme in Information and Construction Technology
- MPhil Programme in Information and Construction Technology

- PhD Programme in Information and Construction Technology
- MPhil Programme in Information and Construction Technology

- PhD Programme in Urban Sustainability Policy
- MPhil Programme in Urban Sustainability Policy

4. Intended Learning Outcomes and Curriculum Maps for Individual Programmes

4.1 PhD Programme in Construction and Real Estate Economics

4.1.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. Develop a systematic understanding of advanced knowledge in Construction and Real Estate Economics 2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 5. Develop effective communication skills for both academic and non-academic communities
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. Develop the ability to solve challenging problems related to Construction and Real Estate Economics through the generation of new knowledge 4. Understand the importance and strategic values of their research
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	5. Develop effective communication skills for both academic and non-academic communities

4.1.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BRE612 Productivity in Construction	BRE666 Numerical Methods for Engineers	BRE671-BRE674* Attendance in research seminars/ workshops/ conferences	BRE675-BRE676* Practicum	Thesis*
1. Develop a systematic understanding of advanced knowledge in Construction and Real Estate Economics					✓		✓	✓		✓	✓	✓			✓
2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods					✓	✓	✓	✓	✓	✓	✓	✓			✓
3. Develop the ability to solve challenging problems related to Construction and Real Estate Economics through the generation of new knowledge					✓		✓			✓	✓	✓			✓
4. Understand the importance and strategic values of their research				✓	✓	✓		✓	✓	✓	✓		✓	✓	✓
5. Develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.2 MPhil Programme in Construction and Real Estate Economics

4.2.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. Develop a systematic understanding of advanced knowledge in Construction and Real Estate Economics 2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 5. Develop effective communication skills for both academic and non-academic communities
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. Develop the ability to solve challenging problems related to Construction and Real Estate Economics 4. Understand the importance and strategic values of their research
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	5. Develop effective communication skills for both academic and non-academic communities

4.2.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BRE612 Productivity in Construction	BRE666 Numerical Methods for Engineers	BRE671-BRE672* Attendance in research seminars/ workshops/ conferences	Thesis*
1. Develop a systematic understanding of advanced knowledge in Construction and Real Estate Economics					✓		✓	✓		✓	✓	✓		✓
2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods					✓	✓	✓	✓	✓	✓	✓	✓		✓
3. Develop the ability to solve challenging problems related to Construction and Real Estate Economics					✓		✓			✓	✓	✓		✓
4. Understand the importance and strategic values of their research				✓	✓	✓		✓	✓	✓	✓		✓	✓
5. Develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.3 PhD Programme in Construction and Real Estate Management

4.3.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. Develop a systematic understanding of advanced knowledge in Construction and Real Estate Management 2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 5. Develop effective communication skills for both academic and non-academic communities
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. Develop the ability to solve challenging problems related to Construction and Real Estate Management through the generation of new knowledge 4. Understand the importance and strategic values of their research
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	5. Develop effective communication skills for both academic and non-academic communities

4.3.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BRE612 Productivity in Construction	BRE666 Numerical Methods for Engineers	BRE671-BRE674* Attendance in research seminars/ workshops/ conferences	BRE675-BRE676* Practicum	Thesis*
1. Develop a systematic understanding of advanced knowledge in Construction and Real Estate Management					✓		✓	✓		✓	✓	✓			✓
2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods					✓	✓	✓	✓	✓	✓	✓	✓			✓
3. Develop the ability to solve challenging problems related to Construction and Real Estate Management through the generation of new knowledge					✓		✓			✓	✓	✓			✓
4. Understand the importance and strategic values of their research				✓	✓	✓		✓	✓	✓	✓		✓	✓	✓
5. Develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.4 MPhil Programme in Construction and Real Estate Management

4.4.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. Develop a systematic understanding of advanced knowledge in Construction and Real Estate Management 2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 5. Develop effective communication skills for both academic and non-academic communities
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. Develop the ability to solve challenging problems related to Construction and Real Estate Management 4. Understand the importance and strategic values of their research
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	5. Develop effective communication skills for both academic and non-academic communities

4.4.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BRE612 Productivity in Construction	BRE666 Numerical Methods for Engineers	BRE671-BRE672* Attendance in research seminars/ workshops/ conferences	Thesis*
1. Develop a systematic understanding of advanced knowledge in Construction and Real Estate Management					✓		✓	✓		✓	✓	✓		✓
2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods					✓	✓	✓	✓	✓	✓	✓	✓		✓
3. Develop the ability to solve challenging problems related to Construction and Real Estate Management					✓		✓			✓	✓	✓		✓
4. Understand the importance and strategic values of their research				✓	✓	✓		✓	✓	✓	✓		✓	✓
5. Develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.5 PhD Programme in Information and Construction Technology

4.5.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. Develop a systematic understanding of advanced knowledge in Information and Construction Technology 2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 5. Develop effective communication skills for both academic and non-academic communities
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. Develop the ability to solve challenging problems related to Information and Construction Technology through the generation of new knowledge 4. Understand the importance and strategic values of their research
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	5. Develop effective communication skills for both academic and non-academic communities

4.5.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BRE612 Productivity in Construction	BRE666 Numerical Methods for Engineers	BRE671-BRE674* Attendance in research seminars/ workshops/ conferences	BRE675-BRE676* Practicum	Thesis*
1. Develop a systematic understanding of advanced knowledge in Information and Construction Technology					✓		✓	✓		✓	✓	✓			✓
2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods					✓	✓	✓	✓	✓	✓	✓	✓			✓
3. Develop the ability to solve challenging problems related to Information and Construction Technology through the generation of new knowledge					✓		✓			✓	✓	✓			✓
4. Understand the importance and strategic values of their research				✓	✓	✓		✓	✓	✓	✓		✓	✓	✓
5. Develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.6 MPhil Programme in Information and Construction Technology

4.6.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. Develop a systematic understanding of advanced knowledge in Information and Construction Technology 2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 5. Develop effective communication skills for both academic and non-academic communities
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. Develop the ability to solve challenging problems related to Information and Construction Technology 4. Understand the importance and strategic values of their research
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	5. Develop effective communication skills for both academic and non-academic communities

4.6.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BRE612 Productivity in Construction	BRE666 Numerical Methods for Engineers	BRE671-BRE672* Attendance in research seminars/ workshops/ conferences	Thesis*
1. Develop a systematic understanding of advanced knowledge in Information and Construction Technology					✓		✓	✓		✓	✓	✓		✓
2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods					✓	✓	✓	✓	✓	✓	✓	✓		✓
3. Develop the ability to solve challenging problems related to Information and Construction Technology					✓		✓			✓	✓	✓		✓
4. Understand the importance and strategic values of their research				✓	✓	✓		✓	✓	✓	✓		✓	✓
5. Develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.7 PhD Programme in Urban Sustainability Policy

4.7.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. Develop a systematic understanding of advanced knowledge in Urban Sustainability Policy 2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 5. Develop effective communication skills for both academic and non-academic communities
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. Develop the ability to solve challenging problems related to Urban Sustainability Policy through the generation of new knowledge 4. Understand the importance and strategic values of their research
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	5. Develop effective communication skills for both academic and non-academic communities

4.7.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BRE612 Productivity in Construction	BRE666 Numerical Methods for Engineers	BRE671-BRE674* Attendance in research seminars/ workshops/ conferences	BRE675-BRE676* Practicum	Thesis*
1. Develop a systematic understanding of advanced knowledge in Urban Sustainability Policy					✓		✓	✓		✓	✓	✓			✓
2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods					✓	✓	✓	✓	✓	✓	✓	✓			✓
3. Develop the ability to solve challenging problems related to Urban Sustainability Policy through the generation of new knowledge					✓		✓			✓	✓	✓			✓
4. Understand the importance and strategic values of their research				✓	✓	✓		✓	✓	✓	✓		✓	✓	✓
5. Develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.8 MPhil Programme in Urban Sustainability Policy

4.8.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. Develop a systematic understanding of advanced knowledge in Urban Sustainability Policy 2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 5. Develop effective communication skills for both academic and non-academic communities
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. Develop the ability to solve challenging problems related to Urban Sustainability Policy 4. Understand the importance and strategic values of their research
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	5. Develop effective communication skills for both academic and non-academic communities

4.8.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	BRE612 Productivity in Construction	BRE666 Numerical Methods for Engineers	BRE671-BRE672* Attendance in research seminars/ workshops/ conferences	Thesis*
1. Develop a systematic understanding of advanced knowledge in Urban Sustainability Policy					✓		✓	✓		✓	✓	✓		✓
2. Develop scientific literacy, including critical thinking, analytical skills, and sound research methods					✓	✓	✓	✓	✓	✓	✓	✓		✓
3. Develop the ability to solve challenging problems related to Urban Sustainability Policy					✓		✓			✓	✓	✓		✓
4. Understand the importance and strategic values of their research				✓	✓	✓		✓	✓	✓	✓		✓	✓
5. Develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

Department of
***C**ivil and **E**nvironmental*
***E**ngineering*

Department of Civil and Environmental Engineering

1. Introduction

The Department of Civil and Environmental Engineering is dedicated to carry out fundamental and application-oriented research to develop scientific, engineering and management solutions that are appropriate to sustain the urban development in densely-populated cities, such as Hong Kong, in Mainland China and other major cities in Asia. We have a strong team of faculties and have achieved an excellent research and publication track record in civil engineering.

The Research Postgraduate Programmes offered by CEE are a combination of coursework and independent research leading to the degree of Master of Philosophy (MPhil) and Doctor of Philosophy (PhD). All of our academic staff are actively engaged in research activities through a range of funding from UGC, RGC, ITF and other sources. The principal research areas in CEE include: Environmental Engineering & Science; Geotechnical Engineering; Coastal & Hydraulic Engineering; Structural Engineering and Construction & Transportation.

2. Aims and Learning Outcomes

The programme of research comprises coursework and thesis and is designed to enable the student to: (1) acquire competence in research methods and scholarship; (2) display sustained independent effort and original thoughts; and (3) to pursue lifelong learning capability for continual professional development. The programmes target to produce academics, researchers or industrial R&D professionals.

The main difference between a Mphil and a PhD degree is that, the Mphil seeks to understand how to stretch the limits of knowledge while a PhD seeks to add to that knowledge by creating more knowledge aside from what is already existent. The degree of Master of Philosophy or Doctor of Philosophy would be awarded to a student who, on completion an approved programme of study and research, presents a thesis embodying the results of his/her research and satisfies the examiners in an oral examination (and other examinations if required) in matters relevant to the subject of the thesis.

Mphil and PhD students are required to satisfactorily investigate or evaluate a chosen area, to show understanding of the context and significance of the work, and to present a clear, complete thesis of a quality worthy of publication.

3. PhD/Mphil Programmes

- PhD Programme in Coastal and Hydraulic Engineering
- Mphil Programme in Coastal and Hydraulic Engineering

- PhD Programme in Construction and Transportation
- Mphil Programme in Construction and Transportation

- PhD Programme in Environmental Engineering and Science
- Mphil Programme in Environmental Engineering and Science

- PhD Programme in Geotechnical Engineering
- Mphil Programme in Geotechnical Engineering

- PhD Programme in Structural Engineering
- Mphil Programme in Structural Engineering

4. Intended Learning Outcomes and Curriculum Maps for Individual Programmes

4.1 PhD Programme in Coastal and Hydraulic Engineering

4.1.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To demonstrate state-of-the-art expertise and knowledge in Coastal and Hydraulic Engineering and possessed superior competence in research methodologies 2. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis 3. To be able to disseminate/ communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	4. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies 5. To create original solutions to issues and problems pertaining to the area of Coastal and Hydraulic Engineering and the society in general
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	6. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Coastal and Hydraulic Engineering

4.1.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6014 Environmental Fluid Mechanics	CSE6721-CSE6724* Research Seminar 1/2/3/4	CSE6710-CSE6711* Practicum 1/2	Thesis*
1. To demonstrate state-of-the-art expertise and knowledge in Coastal and Hydraulic Engineering and possessed superior competence in research methodologies				✓	✓			✓	✓		✓	✓		✓
2. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis				✓	✓	✓				✓		✓	✓	✓
3. To be able to disseminate/communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms	✓	✓	✓			✓	✓					✓		✓
4. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies				✓	✓	✓				✓		✓		✓
5. To create original solutions to issues and problems pertaining to the area of Coastal and Hydraulic Engineering and the society in general						✓			✓		✓	✓		✓
6. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Coastal and Hydraulic Engineering				✓	✓	✓			✓		✓	✓		✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.2 MPhil Programme in Coastal and Hydraulic Engineering

4.2.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Coastal and Hydraulic Engineering 2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Coastal and Hydraulic Engineering 3. To be able to disseminate/ communicate effectively the research findings in publications, conferences and classrooms
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies 5. To generate practical and innovative solutions to problems in Coastal and Hydraulic Engineering
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Coastal and Hydraulic Engineering

4.2.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6014 Environmental Fluid Mechanics	CSE6721-CSE6722* Research Seminar 1/2	Thesis*
1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Coastal and Hydraulic Engineering				✓	✓			✓	✓		✓	✓	✓
2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Coastal and Hydraulic Engineering				✓	✓	✓				✓		✓	✓
3. To be able to disseminate/communicate effectively the research findings in publications, conferences and classrooms	✓	✓	✓			✓	✓					✓	✓
4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies				✓	✓	✓				✓		✓	✓
5. To generate practical and innovative solutions to problems in Coastal and Hydraulic Engineering						✓			✓		✓	✓	✓
6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Coastal and Hydraulic Engineering				✓	✓	✓			✓		✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.3 PhD Programme in Construction and Transportation

4.3.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To demonstrate state-of-the-art expertise and knowledge in Construction and Transportation and possessed superior competence in research methodologies 2. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis 3. To be able to disseminate/ communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	4. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies 5. To create original solutions to issues and problems pertaining to the area of Construction and Transportation and the society in general
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	6. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Construction and Transportation

4.3.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6015 Transportation Optimization and Simulation Methods	CSE6721-CSE6724* Research Seminar 1/2/3/4	CSE6710-CSE6711* Practicum 1/2	Thesis*
1. To demonstrate state-of-the-art expertise and knowledge in Construction and Transportation and possessed superior competence in research methodologies				✓	✓			✓	✓		✓	✓		✓
7. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis				✓	✓	✓				✓		✓	✓	✓
8. To be able to disseminate/ communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms	✓	✓	✓			✓	✓					✓		✓
9. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies				✓	✓	✓				✓		✓		✓
10. To create original solutions to issues and problems pertaining to the area of Construction and Transportation and the society in general						✓			✓		✓	✓		✓
11. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Construction and Transportation				✓	✓	✓			✓		✓	✓		✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.4 MPhil Programme in Construction and Transportation

4.4.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Construction and Transportation 2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Construction and Transportation 3. To be able to disseminate/ communicate effectively the research findings in publications, conferences and classrooms
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies 5. To generate practical and innovative solutions to problems in Construction and Transportation
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Construction and Transportation

4.4.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6015 Transportation Optimization and Simulation Methods	CSE6721-CSE6722* Research Seminar 1/2	Thesis*
1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Construction and Transportation				✓	✓			✓	✓		✓	✓	✓
2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Construction and Transportation				✓	✓	✓				✓		✓	✓
3. To be able to disseminate/communicate effectively the research findings in publications, conferences and classrooms	✓	✓	✓			✓	✓					✓	✓
4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies				✓	✓	✓				✓		✓	✓
5. To generate practical and innovative solutions to problems in Construction and Transportation						✓			✓		✓	✓	✓
6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Construction and Transportation				✓	✓	✓			✓		✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.5 PhD Programme in Environmental Engineering and Science

4.5.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To demonstrate state-of-the-art expertise and knowledge in Environmental Engineering and Science and possessed superior competence in research methodologies 2. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis 3. To be able to disseminate/ communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	4. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies 5. To create original solutions to issues and problems pertaining to the area of Environmental Engineering and Science and the society in general
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	6. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Environmental Engineering and Science

4.5.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6014 Environmental Fluid Mechanics	CSE6721-CSE6724* Research Seminar 1/2/3/4	CSE6710-CSE6711* Practicum 1/2	Thesis*
1. To demonstrate state-of-the-art expertise and knowledge in Environmental Engineering and Science and possessed superior competence in research methodologies				✓	✓			✓	✓		✓	✓		✓
2. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis				✓	✓	✓				✓		✓	✓	✓
3. To be able to disseminate/ communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms	✓	✓	✓			✓	✓					✓		✓
4. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies				✓	✓	✓				✓		✓		✓
5. To create original solutions to issues and problems pertaining to the area of Environmental Engineering and Science and the society in general						✓			✓		✓	✓		✓
6. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Environmental Engineering and Science				✓	✓	✓			✓		✓	✓		✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.6 MPhil Programme in Environmental Engineering and Science

4.6.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Environmental Engineering and Science 2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Environmental Engineering and Science 3. To be able to disseminate/ communicate effectively the research findings in publications, conferences and classrooms
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies 5. To generate practical and innovative solutions to problems in Environmental Engineering and Science
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Environmental Engineering and Science

4.6.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6014 Environmental Fluid Mechanics	CSE6721-CSE6722* Research Seminar 1/2	Thesis*
1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Environmental Engineering and Science				✓	✓			✓	✓		✓	✓	✓
2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Environmental Engineering and Science				✓	✓	✓				✓		✓	✓
3. To be able to disseminate/communicate effectively the research findings in publications, conferences and classrooms	✓	✓	✓			✓	✓					✓	✓
4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies				✓	✓	✓				✓		✓	✓
5. To generate practical and innovative solutions to problems in Environmental Engineering and Science						✓			✓		✓	✓	✓
6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Environmental Engineering and Science				✓	✓	✓			✓		✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.7 PhD Programme in Geotechnical Engineering

4.7.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To demonstrate state-of-the-art expertise and knowledge in Geotechnical Engineering and possessed superior competence in research methodologies 2. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis 3. To be able to disseminate/ communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	4. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies 5. To create original solutions to issues and problems pertaining to the area of Geotechnical Engineering and the society in general
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	6. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Geotechnical Engineering

4.7.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6012 Advances in Geotechnical and Pavement Engineering	CSE6721-CSE6724* Research Seminar 1/2/3/4	CSE6710-CSE6711* Practicum 1/2	Thesis*
1. To demonstrate state-of-the-art expertise and knowledge in Geotechnical Engineering and possessed superior competence in research methodologies				✓	✓			✓	✓		✓	✓		✓
2. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis				✓	✓	✓				✓		✓	✓	✓
3. To be able to disseminate/ communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms	✓	✓	✓			✓	✓					✓		✓
4. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies				✓	✓	✓				✓		✓		✓
5. To create original solutions to issues and problems pertaining to the area of Geotechnical Engineering and the society in general						✓			✓		✓	✓		✓
6. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Geotechnical Engineering				✓	✓	✓			✓		✓	✓		✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.8 MPhil Programme in Geotechnical Engineering

4.8.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Geotechnical Engineering 2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Geotechnical Engineering 3. To be able to disseminate/ communicate effectively the research findings in publications, conferences and classrooms
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies 5. To generate practical and innovative solutions to problems in Geotechnical Engineering
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Geotechnical Engineering

4.8.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6012 Advances in Geotechnical and Pavement Engineering	CSE6721-CSE6722* Research Seminar 1/2	Thesis*
1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Geotechnical Engineering				✓	✓			✓	✓		✓	✓	✓
2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Geotechnical Engineering				✓	✓	✓				✓		✓	✓
3. To be able to disseminate/communicate effectively the research findings in publications, conferences and classrooms	✓	✓	✓			✓	✓					✓	✓
4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies				✓	✓	✓				✓		✓	✓
5. To generate practical and innovative solutions to problems in Geotechnical Engineering						✓			✓		✓	✓	✓
6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Geotechnical Engineering				✓	✓	✓			✓		✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.9 PhD Programme in Structural Engineering

4.9.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To demonstrate state-of-the-art expertise and knowledge in Structural Engineering and possessed superior competence in research methodologies 2. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis 3. To be able to disseminate/ communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	4. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies 5. To create original solutions to issues and problems pertaining to the area of Structural Engineering and the society in general
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	6. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Structural Engineering

4.9.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6010 Nonlinear Finite Element Analysis of Structures	CSE6011 Structural Performance Monitoring	CSE6013 Life Cycle Performance Management of Concrete Infrastructure	CSE6721-CSE6724* Research Seminar 1/2/3/4	CSE6710-CSE6711* Practicum 1/2	Thesis*
1. To demonstrate state-of-the-art expertise and knowledge in Structural Engineering and possessed superior competence in research methodologies				✓	✓			✓	✓		✓	✓	✓	✓		✓
2. To contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis				✓	✓	✓				✓				✓	✓	✓
3. To be able to disseminate/ communicate the research ideas and findings effectively and efficiently in publications, conferences and classrooms	✓	✓	✓			✓	✓							✓		✓
4. To become innovative problem solvers with excellent mastery of critical and creative thinking methodologies				✓	✓	✓				✓				✓		✓
5. To create original solutions to issues and problems pertaining to the area of Structural Engineering and the society in general						✓			✓		✓	✓	✓	✓		✓
6. To engage in an enduring quest for knowledge and an enhanced capability for continual academic (include teaching)/professional development through self-directed research in Structural Engineering				✓	✓	✓			✓		✓	✓	✓	✓		✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.10 MPhil Programme in Structural Engineering

4.10.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Structural Engineering 2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Structural Engineering 3. To be able to disseminate/ communicate effectively the research findings in publications, conferences and classrooms
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies 5. To generate practical and innovative solutions to problems in Structural Engineering
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Structural Engineering

4.10.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	CSE6010 Nonlinear Finite Element Analysis of Structures	CSE6011 Structural Performance Monitoring	CSE6013 Life Cycle Performance Management of Concrete Infrastructure	CSE6721-CSE6722* Research Seminar 1/2	Thesis*
1. To demonstrate advanced competence in research methods and possess in-depth knowledge and skills in Structural Engineering				✓	✓			✓	✓		✓	✓	✓	✓	✓
2. To attain the ability to apply the knowledge and act as leaders in analysing and solving identified issues and problems in Structural Engineering				✓	✓	✓				✓				✓	✓
3. To be able to disseminate/communicate effectively the research findings in publications, conferences and classrooms	✓	✓	✓			✓	✓							✓	✓
4. To become versatile problem solvers with good mastery of critical and creative thinking methodologies				✓	✓	✓				✓				✓	✓
5. To generate practical and innovative solutions to problems in Structural Engineering						✓			✓		✓	✓	✓	✓	✓
6. To enhance capability for continual professional development through inquiry and reflection on knowledge in Structural Engineering				✓	✓	✓			✓		✓	✓	✓	✓	✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

Department of
***L**and **S**urveying and*
***G**eo-**I**nformatics*

Department of Land Surveying and Geo-Informatics

1. Introduction

Established in 1984, the Department of Land Surveying and Geo-Informatics (LSGI) is the only academic unit amongst the local tertiary institutions offering a range of opportunities for education, training and research in the fields of Land Surveying and Geo-Informatics (or Geomatics). The Department has close links with both international and local academic institutions and the professions. By maintaining links with the local professional community through our community service and consultancy activities, our courses and research are oriented towards the needs of Hong Kong.

The Department has identified Urban Informatics and Smart City as its strategic area, with three corresponding focused research directions: a) spatial big data modelling and analytics; b) smart positioning and smart mobility; and c) urban sensing and measurement. As a regional centre of excellence in geomatics research, LSGI is comparable with international reputed academic units in the discipline, as evidenced by both the quantity and quality of the research produced and research grants received.

2. Aims and Learning Outcomes

The Research student programmes aim to provide rigorous training to students who aspire to become researchers or scholars capable of conducting independent and original research, and producing research findings that are relevant and significant to their chosen field of specialisation. To be awarded the degree, students must demonstrate their research competence by submitting a thesis and successfully defending it in an oral examination.

Research students (MPhil and/or PhD) must satisfactorily investigate or evaluate a chosen area, demonstrate understanding of the context and significance of the work, display sustained independent effort and original thought, and present a clear, complete thesis of a quality worthy of publication. For PhD students, they are also expected to produce evidence and argument supporting an original proposition or rigorous testing and analysis of others propositions, that results in a significant contribution to knowledge in the subject area.

The research degree programmes are designed in such a way to enable the student to:

- Acquire competence in research methods and scholarship;
- Display sustained independent effort and original thought;
- Develop competence in disseminating and communicating their work; and
- Gain lifelong learning capability.

3. PhD/MPhil Programmes

- PhD Programme in Geomatics
- MPhil Programme in Geomatics

- PhD Programme in Urban Informatics and Smart City
- MPhil Programme in Urban Informatics and Smart City

Geomatics is the discipline of acquiring, processing, managing, modelling and delivering spatially referenced information about the earth and other planets, for a variety of applications such as construction, environment, navigation and transportation. In the discipline of Geomatics, the research areas include Cadastre Survey, Cartography, Geodesy and Geodynamics, Geographic Information Science, GNSS and Positioning systems, hydrographic surveying, Photogrammetry, Navigation technology, Remote Sensing, Utility Surveying.

Urban informatics and Smart Cities is a trans-disciplinary field that draws on three broad domains, i.e. people, place and technology, with ultimate goal of achieving smarter mobility, smart living, smart environment and smart people. This new field is enabled by the increasing availability of big and geographically-rich new urban data, the development of geo-information technologies, and the growth of sensors and connected systems. In the discipline of Urban Informatics and Smart City, the research areas include Urban-space and environment, Urban Systems and Dynamics, Urban Sensing, Ubiquitous Technologies, Big Urban data Analytics and Visualization, etc.

4. Intended Learning Outcomes and Curriculum Maps for Individual Programmes

4.1 PhD Programme in Geomatics

4.1.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To develop a systematic understanding of advanced knowledge in Geomatics 2. To develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. To develop the ability to solve challenging problems related to Geomatics 5. To develop effective communication skills for both academic and non-academic communities
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	4. To understand the importance and strategic values of their research 6. To become an independent researcher in Geomatics
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	1. To develop a systematic understanding of advanced knowledge in Geomatics 6. To become an independent researcher in Geomatics

4.1.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	LSGI631-LSGI634* Attendance in Research Seminars/ Workshops / Conferences I/II/III/IV	LSGI641-LSGI642* Practicum I/II	LSGI651 Advanced GNSS Technology and Applications	LSGI652 Remote Sensing in Construction, Urban and Environment	Thesis*
1. To develop a systematic understanding of advanced knowledge in Geomatics					✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
2. To develop scientific literacy, including critical thinking, analytical skills, and sound research methods				✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
3. To develop the ability to solve challenging problems related to Geomatics							✓	✓	✓	✓			✓	✓	✓
4. To understand the importance and strategic values of their research					✓	✓	✓		✓	✓	✓		✓	✓	✓
5. To develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓
6. To become an independent researcher in Geomatics				✓	✓	✓									✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.2 MPhil Programme in Geomatics

4.2.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To develop an understanding of advanced knowledge in Geomatics 2. To develop the ability to design and conduct scientific research, as well as analyse and interpret data 3. To develop the ability to solve Geomatics problems 5. To develop the ability to disseminate the research outputs in a professional manner
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	4. To understand the importance and strategic values of their research 6. To become a skilled researcher in Geomatics
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	1. To develop an understanding of advanced knowledge in Geomatics 6. To become a skilled researcher in Geomatics

4.2.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	LSGI631-LSGI632* Attendance in Research Seminars/ Workshops / Conferences I/II	LSGI651 Advanced GNSS Technology and Applications	LSGI652 Remote Sensing in Construction, Urban and Environment	Thesis*
1. To develop an understanding of advanced knowledge in Geomatics					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To develop the ability to design and conduct scientific research, as well as analyse and interpret data				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
3. To develop the ability to solve Geomatics problems							✓	✓	✓	✓		✓	✓	✓
4. To understand the importance and strategic values of their research					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. To develop the ability to disseminate the research outputs in a professional manner	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
6. To become a skilled researcher in Geomatics				✓	✓	✓								✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.3 PhD Programme in Urban Informatics and Smart City

4.3.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence PhD graduates of PolyU should demonstrate state-of-the-art expertise and knowledge in their area of study, possessed superior competence in research methodologies and contribute as leaders in creating new knowledge through analysis, diagnosis and synthesis. They should also be able to disseminate/communicate their research ideas and findings effectively and efficiently in publications, conferences and classrooms.	1. To develop a systematic understanding of advanced knowledge in Urban Informatics and Smart City 2. To develop scientific literacy, including critical thinking, analytical skills, and sound research methods 3. To develop the ability to solve challenging problems related to Urban Informatics and Smart City 5. To develop effective communication skills for both academic and non-academic communities
Originality PhD graduates of PolyU will be able to think out of the box. They will be innovative problem solvers with excellent mastery of critical and creative thinking methodologies. They will create original solutions to issues and problems pertaining to their area of expertise and the society in general.	4. To understand the importance and strategic values of their research 6. To become an independent researcher in Urban Informatics and Smart City
Lifelong Learning Capability PhD graduates of PolyU will demonstrate the ability to engage in an enduring quest for knowledge and an enhanced capability for continual academic/professional development through self-directed research in their area of study.	1. To develop a systematic understanding of advanced knowledge in Urban Informatics and Smart City 6. To become an independent researcher in Urban Informatics and Smart City

4.3.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	LSGI631-LSGI634* Attendance in Research Seminars/ Workshops / Conferences I/II/III/IV	LSGI641-LSGI642* Practicum I/II	LSGI651 Advanced GNSS Technology and Applications	LSGI652 Remote Sensing in Construction, Urban and Environment	Thesis*
1. To develop a systematic understanding of advanced knowledge in Urban Informatics and Smart City					✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
2. To develop scientific literacy, including critical thinking, analytical skills, and sound research methods				✓	✓	✓	✓	✓	✓	✓			✓	✓	✓
3. To develop the ability to solve challenging problems related to Urban Informatics and Smart City							✓	✓	✓	✓			✓	✓	✓
4. To understand the importance and strategic values of their research					✓	✓	✓		✓	✓	✓		✓	✓	✓
5. To develop effective communication skills for both academic and non-academic communities	✓	✓	✓	✓	✓	✓	✓			✓		✓	✓	✓	✓
6. To become an independent researcher in Urban Informatics and Smart City				✓	✓	✓									✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

4.4 MPhil Programme in Urban Informatics and Smart City

4.4.1 Programme Intended Learning Outcomes against Institutional Learning Outcomes

Institutional Learning Outcomes	Intended Learning Outcomes of Individual Research Degree Programme
Research and Scholarship Excellence MPhil graduates of PolyU should demonstrate advanced competence in research methods, possess in-depth knowledge and skills in their area of study and attain the ability to apply their knowledge and act as leaders in analysing and solving identified issues and problems in their area of study. They should also be able to disseminate/communicate effectively their research findings in publications, conferences and classrooms.	1. To develop an understanding of advanced knowledge in Urban Informatics and Smart City 2. To develop the ability to design and conduct scientific research, as well as analyse and interpret data 3. To develop the ability to solve Urban Informatics and Smart City problems 5. To develop the ability to disseminate the research outputs in a professional manner
Originality MPhil graduates of PolyU will be versatile problem solvers with good mastery of critical and creative thinking methodologies. They can generate practical and innovative solutions to problems in their area of study.	4. To understand the importance and strategic values of their research 6. To become a skilled researcher in Urban Informatics and Smart City
Lifelong Learning Capability MPhil graduates of PolyU will have an enhanced capability for continual professional development through inquiry and reflection on knowledge in their area of study.	1. To develop an understanding of advanced knowledge in Urban Informatics and Smart City 6. To become a skilled researcher in Urban Informatics and Smart City

4.4.2 Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	ENGL6016* Advanced Academic English for Research Students: Publishing and Presenting	HTI6081* Ethics: Research, Professional & Personal Perspectives	CE603* Research Frontiers in Construction and Environment	CE620^ Research Methods	CE631 Simulation and IT Applications in Construction	CE632 Advanced Energy Technologies and Analytics	CE633 Environment and Climate Change	CE634 Urban Big Data	LSGI631-LSGI632* Attendance in Research Seminars/ Workshops / Conferences I/II	LSGI651 Advanced GNSS Technology and Applications	LSGI652 Remote Sensing in Construction, Urban and Environment	Thesis*
1. To develop an understanding of advanced knowledge in Urban and Informatics and Smart City					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2. To develop the ability to design and conduct scientific research, as well as analyse and interpret data				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
3. To develop the ability to solve Urban Informatics and Smart City problems							✓	✓	✓	✓		✓	✓	✓
4. To understand the importance and strategic values of their research					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5. To develop the ability to disseminate the research outputs in a professional manner	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
6. To become a skilled researcher in Urban Informatics and Smart City				✓	✓	✓								✓

**Compulsory*

^Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort

Part III

Subject Description Forms

List of University / Faculty / Departmental Subjects

Subject Offering Departments	Subject Code	Subject Title
University subjects		
English Language Centre (ELC)	ELC6001[1]	Presentation Skills for Research Students
	ELC6002[1]	Thesis Writing for Research Students
Department of English (ENGL)	ENGL6016[1]	Advanced Academic English for Research Students: Publishing and Presenting
Department of Health Technology and Informatics (HTI)	HTI6081[2]	Ethics: Research, Professional & Personal Perspective
Faculty subjects		
Faculty of Construction and Environment (FCE)	CE603[3]	Research Frontiers in Construction and Environment
	CE620[4]	Research Methods
	CE631	Simulation and IT Applications in Construction
	CE632	Advanced Energy Technologies and Analytics
	CE633	Environment and Climate Change
	CE634	Urban Big Data
Departmental subjects		
Department of Building Environment and Energy Engineering (BEEE)	BSE6001	Computational Fluid Dynamics
	BSE6004	Fire Science and Fire Safety Engineering
	BSE6005	Indoor and Outdoor Environmental Quality Evaluation and Simulation
	BSE6101-6014[5]	Research Seminar I/II/III/IV
	BSE6105-6016[6]	Practicum I/II
Department of Building and Real Estate (BRE)	BRE612	Productivity in Construction
	BRE666	Numerical Methods for Engineers
	BRE671-674[5]	Attendance in research seminars/workshops/conferences
	BRE675-676[6]	Practicum

Department of Civil and Environmental Engineering (CEE)	CSE6010	Nonlinear Finite Element Analysis of Structures
	CSE6011	Structural Performance Monitoring
	CSE6012	Advances in Geotechnical and Pavement Engineering
	CSE6013	Life Cycle Performance Management of Concrete Infrastructure
	CSE6014	Environmental Fluid Mechanics
	CSE6015	Transportation Optimization and Simulation Methods
	CSE6721-6724[5]	Research Seminar 1/2/3/4
	CSE6710-6711[6]	Practicum 1/2
Department of Land Surveying and Geo-Informatics (LSGI)	LSGI631-634[5]	Attendance in Research Seminars/Workshops/Conferences I/II/III/IV
	LSGI641-642[6]	Practicum I/II
	LSGI651	Advanced GNSS Technology and Applications
	LSGI652	Remote Sensing in Construction, Urban and Environment

Notes:

1. *English enhancement subjects for all RPg students. For exemption, RPg students need to pass the Research Language Skills Assessment (RLSA).*
2. *Compulsory Subjects for all PolyU RPg students*
3. *Compulsory Subject for full-time FCE research students who registered on/after 2 July 2009, and part-time FCE research students who registered on/after 2 July 2014.*
4. *Compulsory for RPg students admitted in the 2022/23 cohort or before; Elective for RPg students admitted in or after the 2023/24 cohort*
5. *Attendance at Seminars is compulsory for all PolyU RPg students (Total 2 credits for MPhil students / Total 3 credits for 3-year PhD students / Total 4 credits for 4-year PhD students).*
6. *Practicum is compulsory for all PolyU PhD students.*

University Compulsory Subjects

Subject Description Form

Subject Code	ELC6001
Subject Title	Presentation Skills for Research Students
Credit Value	Nil
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject aims to develop the spoken English language and communication skills required by research students to present their research projects effectively in academic contexts.
Intended Learning Outcomes	By the end of the subject, students should be able to present their research to academic audiences in research-related contexts such as conferences and vivas through a. planning, organising and delivering effective oral presentations, and b. reporting and defending their research. To achieve the above outcomes, students are expected to use language and organisational structure appropriate to the context, select information critically, justify various aspects of the research, present and support stance and opinion, and analyse the impact and significance of the research.
Subject Synopsis / Indicative Syllabus	The content is indicative. The balance of the components, and the corresponding weighting, will be based on the specific needs of the students. **1. Planning and organising presentations** Identifying purposes and audiences; selecting and organising information and ideas; using appropriate organisational patterns. **2. Using visual aids in presentations** Analysing the characteristics of different types of commonly-used visual aids; selecting visual aids; planning and preparing visual aids; describing graphics; practising the techniques of using different visual aids. **3. Delivering presentations** Using transitions; signposting the presentation; selecting appropriate register; employing non-verbal interactive strategies; handling questions.
Teaching / Learning Methodology	The study method is primarily seminar-based. Activities include teacher input as well as individual and group work. Students will be provided with opportunities to practise giving oral presentations related to their research. Through practice supported by video-recording, students will learn to evaluate their presentations and obtain advice on presentations related to their research. Students will be referred to information on the Internet and the ELC's Centre for Independent Language Learning.

	Learning materials developed by the English Language Centre are used throughout this course. Additional reference materials will be recommended as required.	
Assessment Methods	Continuous assessment: 100% Students' oral skills are evaluated through assessment tasks related to the learning outcomes. Students are assessed on the fluency, accuracy and appropriacy of the language used in fulfilling the assessment tasks, as well as the selection and organisation of ideas.	
Student Study Effort Expected	Class contact	28hrs
Reading List and References	Cauldwell, R. (2002). *Streaming speech: Listening and pronunciation for advanced learners of English* (2nd ed.). Birmingham: Speechinaction. Hancock, M. (2003). *English pronunciation in use*. Cambridge: Cambridge University Press. Jay, A. and Jay, R. (2000). *Effective presentation*. London: Prentice Hall. Madden, C.G. & Rohlck, T.N. (1997). *Discussion and interaction in the academic community*. Ann Arbor, MI: University of Michigan Press. Reinhart, S. (2002). *Giving academic presentations*. Ann Arbor, MI: University of Michigan Press.	

Subject Description Form

Subject Code	ELC6002
Subject Title	Thesis Writing for Research Students
Credit Value	Nil
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject aims to improve students' ability to analyse and apply generic structures and linguistic features in postgraduate degree theses.
Intended Learning Outcomes	By the end of the subject, students should be able to present their research effectively in a thesis through a. summarising the study in the Abstract, b. introducing the background, rationale and objectives of the study in the Introduction, c. reviewing the literature, d. describing the method used in the study, e. describing and discussing the findings of the study, and f. summarising and assessing the significance of the study in the Conclusion. To achieve the above outcomes, students are expected to use language and text structure appropriate to the context, select information critically, cite and review sources appropriately and critically, present and support stance and opinion, and analyse the impact and significance of the research.
Subject Synopsis / Indicative Syllabus	This syllabus is indicative. The balance of the components, and the corresponding weighting, will be based on the specific needs of the students. With regard to the organisational structures and linguistic features appropriate to different sections of the research thesis, the course will focus on the following: Planning and organising the thesis; summarising, evaluating and citing sources; describing quantitative and qualitative data; presenting interpretations of data; using appropriate grammatical structures, vocabulary and register; achieving coherence and cohesion; maintaining clarity; using appropriate academic style; and revising and proofreading.
Teaching / Learning Methodology	The course is designed to introduce students to the language and skills they will need to write their research thesis effectively. The study method is primarily seminar-based. Activities include teacher input as well as individual and group work involving writing practice, evaluation of texts, mini-presentations and discussions. Practical work will involve analysing texts such as journal articles and theses that are relevant to

	students' research areas. Students will be provided with opportunities to apply the language skills acquired to the preparation of their own thesis. Students will be referred to information on the Internet and the ELC's Centre for Independent Language Learning. Learning materials developed by the English Language Centre are used throughout this course. Additional reference materials will be recommended as required.	
Assessment Methods	Continuous assessment: 100% Students will be assessed on their cohesion and coherence, linguistic accuracy and language appropriateness in fulfilling the task requirements of assignments and activities related to the learning outcomes.	
Student Study Effort Expected	Class contact	42hrs
Reading List and References	Calabrese, R.L. (2006). *The elements of an effective dissertation and thesis: A step-by-step guide to getting it right the first time*. Lanham, MD: Rowman & Littlefield. Cooley, L. and Lewkowicz, J. (2003). *Dissertation writing in practice: Turning ideas into text*. Hong Kong: Hong Kong University Press. Dunleavy, P. (2003). *Authoring a PhD: How to plan, draft, write, and finish a doctoral dissertation*. Basingstoke; New York: Palgrave Macmillan. Foss, S.K. & Waters, W. (2007). *Destination dissertation: A traveler's guide to a done dissertation*. Lanham, MD: Rowman & Littlefield Publishers. Golden-Biddle, K. & Locke, K. (2007). *Composing qualitative research*. Thousand Oaks, CA: Sage. Luey, B. (Ed.). (2008). Revising your dissertation: *Advice from leading editors* (2nd ed.). Berkeley, CA: University of California Press. Lunenburg, F.C. & Irby, B.J. (2008). *Writing a successful thesis or dissertation: Tips and strategies in the social and behavioural sciences*. Thousand Oaks, CA: Corwin Press. Potter, S. (Ed.). (2006). *Doing postgraduate research* (2nd ed.). Milton Keynes: Open University; London: Sage. Swales, J.M. & Feak, C.B. (2000). *English in today's research world: A writing guide*. Ann Arbor: University of Michigan Press. Swales, J.M. & Feak, C.B. (2004). *Academic writing for graduate students: Essential tasks and skills* (2nd ed.). Ann Arbor, MI: University of Michigan Press. Weissberg, R. and Buker, S. (1990). *Writing up research: Experimental research report writing for students of English*. Englewood Cliffs, NJ: Prentice Hall Regents.	

Subject Description Form

Subject Code	ENGL6016
Subject Title	Advanced Academic English for Research Students: Publishing and Presenting
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	None
Objectives	The objective of the subject is to enable research postgraduate students to publish successfully in international journals and deliver effective conference presentations. This is achieved by equipping students with the essential English language skills and linguistic knowledge to effectively communicate the background, rationale, findings, and significance of their research. Students will be guided systematically to (1) improve their academic English; (2) acquire and apply knowledge of the generic and linguistic features of conference presentations and research articles; and (3) increase the persuasiveness of their spoken and written discourse. The primary focus will be on writing research articles.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Be familiar with the differences between spoken and written academic English; b. Analyze and apply generic structures and linguistic features in research writing; c. Write research articles in clear, accurate and appropriate English; d. Prepare articles for publication in light of comments from editors and reviewers; e. Structure and deliver clear and persuasive presentations in English.
Subject Synopsis / Indicative Syllabus	Part 1 – Publishing in international journals: (2/3) ▪ Interacting with readers; ▪ Writing effective introductions and literature reviews; ▪ Describing research methods; ▪ Discussing the implications and significance of the findings; ▪ Drawing conclusions; ▪ Writing abstracts; and ▪ Addressing editors' and reviewers' comments.

<table>
<tr><td></td><td>Part 2 – Delivering an effective conference presentation: (1/3)
Structuring and delivering conference presentations in clear and appropriate academic English;
Interacting with an audience and responding to questions.</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>A learner-centered and highly interactive mode of teaching will be adopted. Students will engage in activities where they can share their experience and concerns, put forth their own thinking and comment on each other’s research ideas, and critique each other’s academic writings. Students will be encouraged and guided to discover for themselves the various linguistic and generic features of successful presentations and academic writing through intellectually challenging tasks.</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</td><td>b</td><td>c</td><td>d</td><td>e</td></tr>
<tr><td>1. Individual presentation</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Term paper</td><td>50%</td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Class participation</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100%</td><td colspan="5"></td></tr>
</table>

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

<u>Individual presentation</u>
Students will prepare a 15-minute conference presentation in which they demonstrate their ability to use appropriate academic English and engage effectively with the audience.

<u>Term paper</u>
This assignment requires students to critique a research article to demonstrate their knowledge of the generic and linguistic features of research articles. Their ability to present ideas and arguments coherently and persuasively using appropriate academic English will also be assessed. The term paper could be in the form of a research article from the student’s field.

<u>Class participation</u>
Student’s active participation and engagement with the learning activities will be part of the assessment of the subject.</td></tr>
</table>

Student Study Effort Expected	Class contact:	
	▪ Interactive lectures	39 Hrs.
	▪	Hrs.
	Other student study effort:	
	▪ Reading	42 Hrs.
	▪ Preparation for assignments	30 Hrs.
	Total student study effort	111 Hrs.
Reading List and References	Hyland, K. (2006). English for Academic Purposes: An Advanced Resource Book. Oxon; New York: Routledge. Jalongo, M., and Machado, C. (2016). Making effective presentations at professional conferences: a guide for teachers, graduate students and professors. Cham: Springer. Kline, J.A. (2004). Speaking Effectively: Achieving Excellence in Presentations, Upper Saddle River, N.J.: Pearson/Prentice Hall. Reinhart, S.M. (2002). Giving Academic Presentations, Ann Arbor, Michigan: University of Michigan Press. Strunk, W. & White, E.B. (2000) The Elements of Style, New York: Pearson. Swales, J. & Christine, F. (2012). Academic writing for graduate students: Essentials tasks and skill (3rd ed.) Ann Arbor: University of Michigan. Wallace, M. & Wray, A. (2011). Critical Reading and Writing for Postgraduates. London; California; New Delhi; Singapore: SAGE.	

Subject Description Form

Subject Code	HTI6081
Subject Title	Ethics: Research, Professional & Personal Perspective
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	None
Objectives	To equip students with a deep appreciation of ethical guidelines and codes of conduct that they can apply in their research studies at PolyU and in their future professional and personal lives.
Intended Learning Outcomes	On successful completion of this subject, students will be able to: a. Demonstrate knowledge and understanding of the need for ethical behavior and guiding codes of ethics in research and the professions. b. Understand, discuss and apply ethical principles and codes across a range of disciplines and scenarios c. Demonstrate awareness of current ethical issues and problems in relation to their own discipline and research area d. Critically analyze and discuss scenarios cases of possible or actual ethical misconduct e. Discuss how the guiding principles of ethics in research extend and apply to business, professional and personal codes of conduct and why this important to integrity and the well being of business, the professions and our community. f. Show a fundamental understanding of the issues of copyright, plagiarism and proper citation, and be able to apply this in their own work.
Subject Synopsis / Indicative Syllabus	• The need for ethics training and the meaning of ethical behavior in research: case studies, disasters and learning by the mistakes of other • Philosophy and codes of ethics and their origins • Culture, religion and the law – how these relate to ethical codes of conduct • Obtaining ethical approval for a research project: procedures and processes • Ethics in life science, humanities, education, business and industry: common issues, guiding principles, discipline specific scenarios • Ethics and human behavior: individual, professional and societal responsibilities

<table>
<tr><td></td><td>

Recent ethical issues affecting Hong Kong and the society in general
Ethical use of information in thesis writing: understanding copyright, plagiarism and proper citation

</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>Lecture/seminar/workshop</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td></tr>
<tr><td>1. Group assignment on discipline specific scenario/ case study analysis</td><td>50%</td><td>✓</td><td></td><td>✓</td><td></td><td></td><td>✓</td></tr>
<tr><td>2. Oral presentation</td><td>30%</td><td></td><td>✓</td><td></td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>3. Attendance</td><td>20%</td><td></td><td></td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>

Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:
1. Discipline specific scenario/case study analysis will assess ability to identify and analyze ethical issues in the student’s own discipline and to present a coherent and detailed critique and plan on how these could be avoided or resolved (giving sources and written work accompanied by a Turn-it-in Report). The group assignment will assess the student’s ability to identify, discuss and analyze ethical principles and issues from a wide perspective, and evaluate how individuals, professions and societies benefit from following ethically acceptable behaviour and practices.
2. Oral presentation will assess the students’ ability to present and argue the points in support of their rationale.
</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture/seminar/workshop/oral presentation</td><td>16 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Self study and group work</td><td>27.5 Hrs.</td></tr>
<tr><td>▪ Assignment preparation</td><td>15 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>58.5 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>Materials from the Hong Kong Ethics development website (http://www.icac.org.hk/hkedc/eng/library2.asp)

Materials from EthicsWeb.ca (http://www.ethicsweb.ca/resources/professional/issues.html)

Selected readings and videos Declaration of Helsinki (revised 2008)</td></tr>
</table>

Faculty Subjects

Subject Description Form

Subject Code	CE603
Subject Title	Research Frontiers in Construction and Environment
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to provide students with: 1. a good understanding of the research foci and achievements of the Faculty and its constituent departments 2. a broad perspective of key research issues in the broad field of construction and environment 3. general knowledge of the current status and future challenges of key areas of FCE and their relationship with the student's own research 4. an exposure to different research cultures, techniques and approaches employed in different research areas and how they may be exploited in the student's own work 5. opportunities to interact with leading scholars from the four constituent departments of FCE 6. opportunities to interact with fellow research students to lay the groundwork for future collaborations
Intended Learning Outcomes	Upon completion of the subject, students will possess: a. a broad perspective of key research issues in the field of construction and environment; b. a good knowledge of the wide range of expertise available in the Faculty; c. an understanding of the different approaches employed in different research areas; and d. an awareness of opportunities for research collaborations in the Faculty
Subject Synopsis / Indicative Syllabus	Overview of Research in FCE and selected topics in the field of construction and environment which may include: Urban Planning and Management; Construction Management; Construction Technology; Renewable Energy Applications; Transportation Engineering; Structural Engineering; Environmental Science and Engineering; Geotechnical Engineering; Hydraulic and Coastal Engineering; Remote Sensing and Geographic Information Systems; and Modern Positioning Technology.

<table>
<tr><td>Teaching / Learning Methodology</td><td>A group of academic staff from the four constitute departments of FCE will share the teaching of the subject. The lecturers will all be active researchers in their fields and they will each provide a critical exposition of the current status and future challenges in their own/related research areas. Ample opportunities will be provided for classroom discussions.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td></td><td></td></tr>
<tr><td>1. In-class test*</td><td>60%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Project report</td><td>40%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>
*Students should attempt at least 70% out of the total number of the in-class tests held in individual lectures.

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

In-class tests can evaluate students' understanding gained at each lecture efficiently and effectively.</td></tr>
<tr><td rowspan="6">Student Study Effort Expected</td><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>39 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>24 Hrs.</td></tr>
<tr><td>▪ Writing project report</td><td>60 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>123 Hrs.</td></tr>
<tr><td>Reading List and References</td><td>To be provided by individual teaching staff.</td></tr>
</table>

Subject Description Form

Subject Code	CE620
Subject Title	Research Methods
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Basic knowledge on Probability
Objectives	• To provide an understanding of the fundamental principles and techniques for scientific research. • To enable students to properly identify and apply appropriate research methodologies to their research problems. • To enable students become proficient in data analysis, statistical tests and writing for scientific research.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Understand research theory, research basics and scientific thinking. b. Understand a range of research methods for exploratory data analysis and modelling techniques. c. Master techniques for thesis/paper/proposal writing and scientific presentation. d. Appreciate the limitation of the learned theory/methods/techniques. e. Apply the learned theory/methods/techniques to their research projects.
Subject Synopsis / Indicative Syllabus	**Research theory** Research basics. Research theory. Research method. Research ethics. Research attitude. Research values. Research wisdom. PhD Research. **Research cycle: from broad topic to hypothesis** Selection of research topic. Understanding and interpretation of the literature. Recognition of new questions. Research hypothesis. Making hypothesis. Design of experiments. Analysis and interpretation of the results. Presentation of the results. **Research design** Components of experimental design. Guidelines for experiment design. Cause-effect analysis. Ideas to learn from classic scientific experiments. Consideration of unexplained variations. Sample size. Sampling strategy. Significance.

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Research thinking

Components and ways of creative thinking. Ways of thinking leading to great innovation. Ways of thinking by great scientists and inventors. General scientific principles to guide thinking. Ways to improve creativity. Creative block.

Research writing/presentation

Ways of writing. Type of proposals and proposal writing. Construction of title/heading and logic flow. Techniques for writing abstract, introduction, body, discussion and conclusion. Guidelines for organizing citations and references. Ethics issue. Common mistakes in presentation. Guidelines for good presentation.

Statistical analysis and modelling

Linear regression. Multiple linear regression. Geographical weighted regression. Robust regression. Outliers detection. Association rules mining. Clustering. Time series analysis. Big data analysis.

Result interpretation: Statistical significance tests

Steps in Testing for Statistical Significance. Selection of a probability of error level (alpha level). Various tests (Chi square test, T-test, U-test, Z-test). Interpretation of test results.

</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>Lectures and class discussions are followed by problem based tutorial assignments that are used to practice of theory and methods learnt during lectures in solving student’s discipline oriented problems.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td></td></tr>
<tr><td>1. Assignments</td><td>20%</td><td></td><td>✓</td><td>✓</td><td></td><td>✓</td><td></td></tr>
<tr><td>2. Tests</td><td>40%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>3. Projects</td><td>40%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>

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

Assignments and projects are designed to apply learned concepts to practical problems.

Tests are designed to formally assess the intended learning outcomes.

Students are expected to achieve a minimum standard to be able to obtain a passing grade in line with criterion referenced assessment approach.

</td></tr>
</table>

Student Study Effort Expected	Class contact:	
	▪ Lectures	39 Hrs.
	Other student study effort:	
	▪ Assignments and self-study	81 Hrs.
	Total student study effort	120 Hrs.
Reading List and References	Allhoff F (ed.) 2009 Philosophies of the Sciences: A Guide, John Wiley & Sons. Ang, A. H-S., and Tang, W.H. (2007). *Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering*, 2nd Edition, Wiley, John Wiley & Sons, Inc. Campbell S 2004 Flaws and Fallacies in Statistical Thinking. Dover Publications. Dielman TE 2009 Applied Regression Analysis, A Second Course in Business and Economic Statistics, South-Western, Fourth Ed. Dowson C 2007 A Practical Guide to Research Methods, Spring Hill House. Gonick and Smith 1993 Cartoon Guide to Statistics, Harper Perennial Pub. Good PI, JW Harvin 2003 Common Errors in Statistics (and how to avoid them) Wiley. MINITAB Manual: Introduction to the Practice of Statistics,. Univ. of Toronto. http://www.msubilings.edu/mathfaculty/mmcbride/MiniTabManual.pdf Kutner, Nachhtsheim, and Neter 2004 Applied Linear Regression Models, McGraw Hill. Pólya G. 1945 How to Solve It, Princeton University Press. Rugg G, MPetre 2007 A Gentle Guide to Research Methods, Open University Press, McGraw-Hill Education. Trochim WM2012 Research Methods Knowledge Base, Cornell University, http://trochim.human.cornell.edu/kb/index.htm. Walliman NSR 2011 Research methods: the basics. London: Routledge.	

Subject Description Form

Subject Code	CE631
Subject Title	Simulation and IT Applications in Construction
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This course provides an overview of quantitative methods used for design and analysis of construction operations to maximize productivity and resource utilization through Discrete Event Simulation (DES), System Dynamics (SD), and Agent Based Simulation (ABS). This subject intended to equip students with an understanding of the roles of Geo-IT and Building Information Modelling (BIM) in practice and research, and introduce a state-of-the-art Geo-IT and BIM-based technologies for construction simulation and management.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Understand the fundamentals of simulation and IT principles. b. Understand the techniques of data analysis and modelling in simulation and IT areas. c. Apply knowledge of simulation and IT to construction projects. d. Communicate with others in a clear and articulated manner. e. Identify and propose solutions to construction productivity and presentation problems. f. Identify and study the appropriateness, advantages, and limitations of each simulation and IT techniques for different construction problems.
Subject Synopsis / Indicative Syllabus	The subject will cover the following content: **Queueing Theory:** a brief introduction to queueing theory, its relationship with simulation, discussion of queueing theory assumptions and limitations in construction applications, and then comparison with simulation approach. **Discrete Event Simulation (DES):** introduction to the principles of modelling and simulation using the DES approach, Monte Carlo simulation approach and its application to construction operations, analysis of simulation input data and outputs, introduction to simulation languages in construction, and then focus on simulation for construction operations associated with the related analysis. Specific emphasis will be placed on modelling and simulating heavy and highway construction,

	underground construction technologies, as well as earthmoving, building construction, and tunnelling operations. Also, WebCYCLONE, STROBOSCOPE/EZSTROBE, Keystone, and CRYSTALBALL simulation packages will be introduced. **System Dynamics (SD):** introduction to the principles of modelling using SD approach, design models for construction operations using SD with a focus on earthmoving operations and civil engineering. Vensim package will be introduced. **Agent Based Simulation (ABS):** introduction to the principles of modelling using ABS approach, comparison of DES, SD, and ABS as well as their advantages and limitations in construction and civil engineering applications. AnyLogic and ABSEMO software will be introduced. **Building Information Modeling (BIM):** • Introduction to BIM, and its applications in project planning, construction management, and property/facility management. • Introduction to the state-of-the-art BIM-based technologies. • Discussion on future research on BIM. Geo-IT for Construction Simulation and Management: • Introduction to Geo-IT, GIS, and their applications in construction simulation and management. • 3D mapping and modelling of outdoor and indoor environments of construction sites using UAV-based photogrammetry and simultaneous localization and mapping (SLAM) technologies. • 3D GIS based analytics for construction simulation and management. • Integration of GIS and BIM for construction simulation and management.
Teaching / Learning Methodology	The course includes a combination of lectures, assigned readings, quizzes, a series of weekly individual assignments, and a class project (term project) for modelling and analysing actual construction operations in addition to one test. The lectures aim to provide the students fundamental concepts and principles of advanced simulation, Geo-IT and BIM technologies to solve construction problems. Assigned readings from literature will guide students to better understand the discussed material through active learning approach. Assignments will improve the problem solving skills for students. Students will be asked to complete a term project on their

<table>
<tr><td></td><td>topic of interest.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><th rowspan="2">Specific assessment methods/tasks</th><th rowspan="2">% weighting</th><th colspan="6">Intended subject learning outcomes to be assessed</th></tr>
<tr><th>a</th><th>b</th><th>c</th><th>d</th><th>e</th><th>f</th></tr>
<tr><td>1. Quizzes</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>2. Project</td><td>40%</td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Test</td><td>40%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>
</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>39 Hrs.</td></tr>
<tr><td>▪ Project Seminars</td><td>11 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>46 Hrs.</td></tr>
<tr><td>▪ Writing project report</td><td>24 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>120 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>

Halpin, Daniel W. and Riggs, Leland S. (1992). Planning and Analysis of Construction Operations. John Wiley & Sons, New York, NY.
Banks, J., Carson II, J., Nelson, B., and Nicol, D. (2010). Discrete-Event System Simulation. 5th Edition, Pearson Prentice Hall, Pearson Education, Inc., Upper Saddle River, NJ.
Jabri, A. and Zayed, T. (2017). “Agent-based modelling and simulation of earthmoving operations,” J. of Automation in Construction, September, 81: 210-223.
Mirahadi, F. and Zayed, T. (2016). “Simulation-Based Construction Productivity Forecast Using Neural-Network-Driven Fuzzy Reasoning,” J. of Automation in Construction, May, Vol. 65, pp. 102-115.
Alzraiee, H., Zayed, T., and Moselhi, O. (2015). “Dynamic Planning of Construction Activities using Hybrid Simulation,” J. of Automation in Construction, Volume 49, Part B, Jan, PP. 176-192
Elwakil, E. and Zayed, T. (2014). “Construction Knowledge Discovery System Using Fuzzy Approach,” Canadian J. of Civil Engineering (CJCE), October, 42(1): 22-32.
Liu, Y. and Zayed, T. (2014). “Cash Flow Modeling Construction Projects,” J. of Engineering, Construction and Architectural Management, February, 21(2): 170-189.
El-Abbasy, M., Zayed, T., Ahmed, M., Alzraiee, H., and Abouhamad, M. (2013). “Contractor Selection Model For Highway Projects Using Integrated Simulation and Analytic Network Process,” J. of Construction Engineering and Management, ASCE, July, 139(7): 755-767.
Zayed, T. (2009). “Stochastic Productivity Assessment of Continuous Flight Auger Piles,” J. of Architectural Science Review (ASR), Australia, March, 52(1): 13-23.
Zhang, C., Zayed, T., and Hammad, A. (2008). “Resource Mgmt of

</td></tr>
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Bridge Deck Rehabilitation: Jacques Cartier Bridge Case Study," J. of Construction Eng. & Mgmt, ASCE, May, 134(5): 311-319.

- Zayed, T. and Halpin, D. (2004). "Simulation as a Tool for piles Productivity Assessment," J. of Construction Eng and Mgmt, ASCE, May/June, 130(3): 394-404.
- Zayed, T. and Halpin, D. (2001). "Simulation of Concrete Batch Plant Production," J. of Construction Eng. and Management, ASCE, April, 127(2): 132-141.
- B. Wu, 2017. Photogrammetry – 3D from Imagery, In D. Richardson, N. Castree, M.F. Goodchild, A. Kobayashi, W. Liu, and R.A. Marston (Ed.): The International Encyclopedia of Geography, John Wiley & Sons, Ltd., New York, pp. 1-13, doi: 10.1002/9781118786352.wbieg0942.
- B. Wu and S. Zhang, 2016. Integration of GIS and BIM for Indoor Geovisual Analytics. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, vol. XLI-B2, pp.455-458, doi:10.5194/isprs-archives-XLI-B2-455-2016.
- Eastman, C., Eastman, C.M., Teicholz, P., Sacks, R. and Liston, K. (2011). BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, John Wiley & Sons.
- Bryde, D., Broquetas, M. and Volm, J.M. (2013). The Project Benefits of Building Information Modelling (BIM), International Journal of Project Management, Volume 31, Number 7, pp. 971-980.
- Yalcinkaya, M., & Singh, V. (2015). Patterns and trends in building information modelling (BIM) research: A latent semantic analysis. Automation in construction, 59, 68-80.
- Becerik-Gerber, B., Kensek, K. (2009). Building information modelling in architecture, engineering, and construction: Emerging research directions and trends. Journal of professional issues in engineering education and practice, 136(3), 139-147.
- Volk, R., Stengel, J., & Schultmann, F. (2014). Building Information Modeling (BIM) for existing buildings – Literature review and future needs. Automation in construction, 38, 109-127.
- Wong, J.K.W., & Zhou, J. (2015). Enhancing environmental sustainability over building life cycles through green BIM: A review. Automation in Construction, 57, 156-165.
- Succar, B. (2009). Building information modeling framework: A research and delivery foundation for industry stakeholders. Automation in construction, 18(3), 357-375.

Subject Description Form

Subject Code	CE632
Subject Title	Advanced Energy Technologies and Analytics
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject aims to introduce the advanced energy technologies and the associated analytical methodologies for three important applications: energy optimization and diagnostic technologies to reduce energy demand, technologies for effective use of various renewable energy resources, and thermal/electrical energy storage technologies
Intended Learning Outcomes	a. Able to appreciate and select proper advanced energy technologies for energy saving, effective use of renewable energy and power supply-demand balance in the context of buildings and districts; b. Able to analyze quantitatively the above energy technologies for the purposes of technologies integration, optimization and operation/control; c. Able to identify the limitations of the technologies in applications and gaps which need for future development.
Subject Synopsis / Indicative Syllabus	**Design and control optimization technologies:** Uncertainty analysis and uncertainty-based control and design, modelling and optimization for real-time applications, smart grid, demand response methods and grid-responsive buildings. **Diagnostic technologies:** Data analytics for building performance diagnostics: (measurement quality, data fusion and data-driven methods); Big Data analytics and their applications in buildings (data mining techniques, supervised learning and unsupervised learning). **Solar energy technologies:** Passive solar energy, building-integrated solar photovoltaics, solar cells (thin film solar cells, perovskite solar cells, dye-sensitized solar cells, organic solar cells), solar thermal energy (solar collectors, solar air-conditioning). **Wind and geothermal energy technologies:** wind power fundamentals, wind turbine technologies (horizontal axis, vertical axis, building-integrated), offshore wind farm, hybrid solar-wind generations, ground source heat pumps. **Energy storage technologies:** Thermal energy storage and phase change materials (PCM); Various fuel cells, such as proton exchange membrane fuel cells (PEMFCs), solid oxide fuel cells (SOFCs), and

<table>
<tr><td></td><td>microbial fuel cells; Various batteries, such as Li-ion battery, Li-air battery, and Zn-air battery.</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>Teaching periods will adopt a range of methods which include lectures, guided reading tutorials, and small projects. The lectures aim to provide the students fundamental concepts and principles as well as quantitative analytic methods of advanced energy technologies. Guided reading will guide students in reading the literature on the selected topics. Tutorial will be used to develop students' problem solving skills. Students will be asked to complete a small project on a selected topic.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td></td><td></td><td></td></tr>
<tr><td>1. Coursework</td><td>25%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>2. Mini-tests</td><td>25%</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3. Oral Examination</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>

Assessments of the subject will be based on coursework (25%), in-class tests (25%), and final examination (50%)

*Oral Examination: Each student will be assessed by two lecturers on two subjects out of the above five topics respectively, each for about twenty minutes on each subject (about 40 minutes for each student). Each student can select one subject and the second is randomly assigned by the subject examiner. The oral examination of each subject consists of two sessions. The first session is the Q/A session on the questions/items given by the lecturer. The second session is the student led discussion. The student will give his/her views and discuss with the lecturer on one topic selected by himself/herself within the subject area. The objective of both sessions is to evaluate the students' understanding and ability in using the knowledge learnt from the viewpoints of depth and breadth. On each subject, a set of basic items/questions will be developed and the lecturer will choose some of these items in the first session of the oral examination.</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>20 Hrs.</td></tr>
<tr><td>▪ Tutorial</td><td>7.5 Hrs.</td></tr>
<tr><td>▪ Student seminars</td><td>6 Hrs.</td></tr>
<tr><td>▪ Test</td><td>2.5 Hrs.</td></tr>
<tr><td>▪ Examination</td><td>3 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>60 Hrs.</td></tr>
</table>
</td></tr>
</table>

	▪ Writing project report	20 Hrs.
	Total student study effort	119 Hrs.
Reading List and References	1. Wang S.W., Intelligent Buildings and Building Automation, Spon Press (Taylor & Francis), London and New York, Nov.2009 2. Shan K, Wang SW, Yan CC and Xiao F. "Building demand response and control methods for smart grids: A review", Science and Technology for the Built Environment, V22(6), pp.692-704, 2016. 3. Wang S.W. and Ma Z.J., "Supervisory and Optimal Control of Building HVAC Systems: A Review", HVAC&R Research, V14(1), pp.3-32, 2008 4. McGowan, John J., Energy and Analytics: Big Data & Building Technology Integration, Published by The Fairmont Press, Inc., 2015. 5. Manwell, J.F., J.G. McGowan and A.L. Rogers, Wind Energy Explained Theory, Design and Application, John Wiley & Sons, Ltd., England, 2010 6. Wortman, A.J., Introduction to Wind Turbine Engineering, Butterworth Publishers, Boston, 1983. 7. Simon J. Rees, Advances in ground-source heat pump systems, Duxford, UK: Woodhead Publishing is an imprint of Elsevier 2016 8. Duffie, J.A. and William A. Beckman, Solar Engineering of Thermal Process, John Wiley & Sons, Inc., 1991. 9. Athienitis, A K and M Santamouris, Thermal Analysis and Design of Passive Solar Buildings, James and James (Science Publishers) Ltd, London, 2002. 10. Partain, L.D., Solar Cells and Their Applications, John Wiley & Sons, Inc., New York, 1995. 11. Sick, F. and Thomas Erge, Photovoltaics in Buildings, James and James (Science Publishers) Ltd., London, 1996. 12. John Wiley and Sons: Handbook of Clean Energy Systems, 2014. 13. Meng Ni, Tim S. Zhao (editors), Solid oxide fuel cells – from materials to system modeling, The Royal Society of Chemistry 2013 14. Peng Tan, Bin Chen, Haoran Xu, Houcheng Zhang, Weizi Cai, Meng Ni, Meilin Liu, Zongping Shao, Flexible Zn- and Li-air batteries: recent advances, challenges, and future perspectives, Energy and Environmental Science, 2017, Issue 10, 2056-2080. 15. Peng Tan, Wei Kong, Zongping Shao, Meilin Liu, Meng Ni, Advances in modeling and simulation of Li-air batteries, Progress in Energy and Combustion Science, 2017, Volume 62, pp.155-189. 16. Bent Sorensen, Hydrogen and Fuel cells (Second Edition), 2012.	

Subject Description Form

Subject Code	CE633
Subject Title	Environment and Climate Change
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Students should have basic knowledge of chemistry, physics, and mathematics.
Objectives	This subject aims to provide students with an overview of the factors affecting the indoor and outdoor environmental quality, and to introduce chemical and physical processes affecting air pollution and climate, and equip Ph.D. students with advanced experimental and modeling skills for conducting atmospheric research.
Intended Learning Outcomes	Upon completion of the subject, students will be able: a. to understand how building system and green building design affect the indoor and outdoor environments, and how to make evaluation through site measurement, and computer simulation. b. to understand advanced chemistry, including gas-phase, aqueous phase and heterogeneous processes, and some physical/dynamical processes related to air pollution and climate change c. to grasp advanced experimental and modeling techniques d. to apply learned knowledge and skills in their atmospheric research
Subject Synopsis / Indicative Syllabus	This subject covers the following contents: **1. <u>Indoor and urban environment</u>** Effect of indoor environmental quality on health, comfort and well-being, aspects of indoor environmental quality and parameters used to describe performance (air, thermal, lighting and acoustics); indoor air quality assessment, key monitoring parameters, relationship between indoor air quality and comfort, health and productivity, indoor air quality guideline, improvement strategies, ventilation and inter-unit dispersion in residential buildings; pedestrian wind and thermal comfort in the urban environment, basic parameters, methods for the improvement. **2. <u>Atmospheric pollution</u>** Atmospheric structure, radiation, stability, circulation, basic chemical kinetics; kinetic theory of gases, chapman mechanism, catalytic cycles, polar ozone depletion; photochemical smog, hydrocarbon oxidation mechanisms, nitrogen oxides, halogens; particulate matter and haze, aerosol composition and sources, mass transfer, formation

<table>
<tr><td></td><td>of sulfate, nitrate and organic aerosols; laboratory experiments and field observations, measurement techniques for criteria pollutants, back trajectories, source apportionment, chemical box model, chemistry transport model.
3. <u>Climate change</u>
Historical overview of climate change science, changes in atmospheric constituents and radiative forcing, factors affecting climate, greenhouse gas effect, past climate records; climate models and their evaluation, understanding and attributing climate change, global and regional projections of future changes in climate; assessment of adaptation practices, options, constraints and capacity, synergies and trade-offs between adaptation and mitigation, assessing key vulnerabilities and the risk from climate change, perspectives on climate change and sustainability, mitigation in varied systems.</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>The students will be divided into groups to finish a group project which will include site measurement and computer simulation. The subject will include lecture, workshop, computer lab session, and seminar.

Lectures: will introduce fundamental knowledge and theoretical basis for indoor air quality, atmospheric chemistry and climate change.

Workshops/seminars: for students to present and discuss key problems and potential issues for selected case studies.

Group project: require students to prepare an individual report based on a specific environment and climate change issues. Students are also required to give an oral presentation.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td></td><td></td></tr>
<tr><td>1. Assignments</td><td>60%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Awritten report and oral presentation</td><td>40%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>
</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>39 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>39 Hrs.</td></tr>
<tr><td>▪ Group project report</td><td>39 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>117 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and</td><td>1. Colin Baird (2012) Environmental Chemistry, Fifth Edition, W.H.</td></tr>
</table>

References	Freeman and Company 2. Seinfeld J H, Pandis S N. Atmospheric chemistry and physics: from air pollution to climate change[M]. John Wiley & Sons, 2016. 3. Jacob D. Introduction to atmospheric chemistry[M]. Princeton University Press, 1999. 4. Brasseur G. and Jacob D., Modeling of Atmospheric Chemistry, Cambridge University Press, 2017. 5. Goosse, H., Climate System Dynamics and Modelling, Cambridge University Press, 2015. 6. IPCC Fourth and Fifth Assessment Report: WG1 – The Physical Science Basis https://www.ipcc.ch/publications_and_data/publications_and_data_reports.shtm 7. Introduction to Climate Change, A.E. Dessler, Cambridge University Press, 2012. QC903.D46EPD 8. 2nd Climate Change consultant report http://www.epd.gov.hk/epd/english/climate_change/files/Climate_Change_Report_final.pdf 9. P.M. Bluyssen (2009) *The Indoor Environmental Handbook*. Earthscan. 10. BEAM Society. *Building Environmental Assessment Method Plus – Existing Buildings*. 11. BEAM Society. *Building Environmental Assessment Method Plus – New Buildings*.

Subject Description Form

Subject Code	CE634
Subject Title	Urban Big Data
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This course aims to provide in-depth knowledge and hands-on techniques on the urban big data mining. This course will introduce the concept of urban big data, and the methods for acquiring, processing, and analysing these data sets. It will also introduce applications in environment, transportation, housing, urban, business, and socio-economics. The research issues in urban big data includes challenges from the automated data management, cloud computing, tackling massive flow, security and privacy problems. This course will cover these issues.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Understand the definition and principles of urban big data b. Obtain broad knowledge in fundamental concepts, algorithms and techniques for big data mining and their applications to large-scale data warehouses and big data analytics c. Understand research issues and topics in big data mining and analytics

Subject Synopsis / Indicative Syllabus	• Introduction of urban big data
	• Big data processing
	  ○ Aggregation
	  ○ Systematic, stochastic, and gross error cleaning
	  ○ Graphic and image cleaning
	  ○ Information delivery
	• Method and techniques in big data analysis and mining
	  ○ Visualization and spatial-temporal analytics
	  ○ Crisp set theory
	  ○ Extended set theory
	  ○ Bionic method
	  ○ GIS data mining
	  ○ Remote sensing image mining
	• Urban big data applications

<table>
<tr><td></td><td>

Transportation
Traffic monitoring
Urban planning
Smart cities
Logistics
Urban Infrastructure
Business
Internet of Things

</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>
1. Lectures to explain theories and methodology;
2. Assignments to reinforce the theories and methodology introduced during the lectures, so as to enable students to gain deeper understanding of the principles and techniques, to become critical in thinking; and
3. A group project is designed to enhance the critical thinking, team spirit, problem solving skill, leadership and presentation skill.
</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td></td><td></td><td></td></tr>
<tr><td>1. Assignments</td><td>60%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>2. Class project</td><td>40%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
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</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>39 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>52 Hrs.</td></tr>
<tr><td>▪ Writing project report</td><td>39 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>130 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>

Textbook:

Spatial data mining: theory and application / Li, Wang, & Li (2015)

Other reading materials:

Applied spatial data analysis with R / Bivand, Pebesma, & Gómez-Rubio (2013)
Applied spatial analysis of public health data / Lance & Carol (2003)
Big data: techniques and technologies in Geoinformatics / Hassan A. Karimi (2014)

</td></tr>
</table>

Departmental Subjects

***B**uilding **E**nvironment and **E**nergy Engineering*

Subject Description Form

Subject Code	BSE6001
Subject Title	Computational Fluid Dynamics
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Mutual exclusions: BSE531 Computational Fire Modelling for Building Design
Objectives	As the computer capacity becomes more and more powerful, and the commercial CFD packages are more widely available, there are increased applications of CFD in postgraduate studies, which eventually will lead to more industrial applications. However, due to the special expertise required, few PhD candidates have the proper fundamental studies with regard to turbulence theory and turbulence modeling, and the special numerical schemes employed to solve the Navier-stokes Partial Differential Equations, which greatly hinders their start-up and further in-depth application of the technique. Therefore, this subject is conceived to fill-up this knowledge gap.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. critically examine turbulence models and understand the limitations of each model; b. select proper models in fluid flow simulation: laminar, RANS or LES; c. treat buoyancy forces; d. use commercial code to simulate flow problems i. grid generation, boundary condition setting ii. selection of numerical schemes and solution procedures iii. convergence control and checking, and iv. visual and numerical presentation of simulation results; and e. solve steady state and transient flow and heat transfer problems.
Subject Synopsis / Indicative Syllabus	1. Conservation equations in fluid flow. 3-d Navier-Stokes Equations, buoyancy force approximation. 2. Concepts of turbulence – Reynolds' experiment, and turbulence measurements and characterization. 3. Reynolds average of flow parameters. 4. Time Average Momentum Equations for turbulence flow. 5. Closure of the Time-Average Equations – turbulence modeling 5.1 Concept of eddy viscosity – Boussinesq Hypotheses 5.2 Concept of mixing length

<table>
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5.3 One Equation models, two equation models, esp. k- model
5.4 Reynolds stress equation models
5.5 Large eddy simulation (LES) and Direction solution of N-Sequations
6. Boundary conditions, the log-wall function method.
7. Numerical Methods for CFD
7.1 Finite volume methods: convection-term discretization method; first-order upwind, and higher-order differencing schemes
7.2 Solution algorithms
7.3 Finite volume method for unsteady flows
8. The use of commercial package.
9. Post-processing, flow visualization and obtaining integral properties.
</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>
The teaching will involve lecture, tutorials and problem solving, and mini-project execution.

In particular heads-on experiences with the use of commercial CFD code FLUENT for simple problems. The simplified problems will be tailor made for each student, and expected to link with their research topics. This learning will involve a mini-project. For instance, a student is requested to calculate the pressure head loss for the pipe flow, or convection heat transfer for the natural convection in an enclosed chamber, via comparing their simulation results with known analytical or benchmark experimental results available in the literature.
</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td></td></tr>
<tr><td>1. Continuous assignments</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>- Case study (mini-project)</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>- Seminar presentation</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Final examination</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
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<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>2 x 7 = 14 Hrs.</td></tr>
<tr><td>▪ Tutorial</td><td>1 x 7 = 7 Hrs.</td></tr>
<tr><td>▪ Seminar</td><td>3 x 2 = 6 Hrs.</td></tr>
<tr><td>▪ Computer simulation: tutorials</td><td>3 x 4 = 12 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Computer simulation and results analysis</td><td>3 x 6 = 18 Hrs.</td></tr>
<tr><td>▪ Self-study</td><td>6 x 11 = 66 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>123 Hrs.</td></tr>
</table>
</td></tr>
</table>

Reading List and References	Recommended text books: 1. Chung, T.J., *Computational Fluid Dynamics*, Cambridge University Press, 2010, 2nd edition. 2. Versteeg, H.K. and Malalasekera, M., *An Introduction to Computational Fluid Dynamics – The Finite Volume Method*, Longman S&T, 1995. 3. Patankar, Suhas V., *Numerical Heat Transfer and Fluid Flow*, McGraw-Hill, Hemisphere, c1980. Journals: 1. International Journal of Heat and Mass Transfer 2. Numerical Heat Transfer 3. International Journal of Heat and Fluid Flow 4. AIAA Journals 5. International Journal of Wind Engineering

Subject Description Form

Subject Code	BSE6004
Subject Title	Fire Science and Fire Safety Engineering
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This course will allow students to understand the fundamentals of fire science and concepts of compartment fire dynamics. It will also help them to develop an understanding of fire growth and the fully developed fire and methods by which potential fire severity can be assessed. Students will learn the application of fire science and fire dynamics for the safety of occupants in buildings, including active and passive fire protection system, the detection, suppression and limiting spread of fire and smoke, and regulatory provisions for fire safety. This course will introduce sufficient knowledge to students and enable them to become future fire protection engineers.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Demonstrate a working knowledge of basic physical and chemical processes in various fire phenomena b. Understand the mechanism of ignition, flame spread, and extinction c. Apply basic sciences to the fire safety design of building d. Identify the fire risk and hazard, and formulate and solve engineering problems representative of those commonly encountered in the fire protection engineering practice e. Recognize the need to engage in life-long learning and ability to maintain state of the art fire protection engineering knowledge and skills.
Subject Synopsis / Indicative Syllabus	1. Combustion Chemistry and Thermodynamics 2. Premixed Flames and Non-premixed Flames 3. Fire Dynamics 3.1 Ignition 3.2 Flame Spread 3.3 Extinction 3.4 Burning 4. Fire Plumes 5. Smoke and Emission 6. Compartment Fires

<table>
<tr><td></td><td>6.1 Pre-Flashover Fires
6.2 Post-Flashover Fires
7. Structure Performance under Fire
8. Wildland Fires
9. Scaling Analysis and Fire Modelling</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>The teaching will involve lecture, Fire lab and computing sessions, tutorials and problem solving, and course projects.
The course project includes the learning of the most successful CFD-based fire code, Fire Dynamics Simulation (FDS), developed by National Institute of Standards and Technology (NIST). Students will learn to use this academic code to further understand the fire behaviours and simulate the smoke propagation in the building fire. By doing this course project, students will be able to conduct fire safety assessment in the design of building, and reproduce the fire process in the case of fire investigation.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning Outcomes</td><td>
<table>
<tr><th rowspan="2">Specific assessment methods/tasks</th><th rowspan="2">% weighting</th><th colspan="6">Intended subject learning outcomes to be assessed</th></tr>
<tr><th>a</th><th>b</th><th>c</th><th>d</th><th>e</th><th></th></tr>
<tr><td>1. Course project</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>2. Presentation</td><td>15%</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>3. Midterm</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>4. Final exam</td><td>35%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
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</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>2 x 11 = 22 Hrs.</td></tr>
<tr><td>▪ Seminar/Presentation</td><td>1 x 7 = 7 Hrs.</td></tr>
<tr><td>▪ Tutorial</td><td>1 x 10 = 10 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Project</td><td>3 x 8 = 24 Hrs.</td></tr>
<tr><td>▪ Self-study</td><td>5 x 11 = 55 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>118 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>Textbooks:
1. James G. Quintiere, Fundamentals of fire phenomena, John Wiley, 2006.
2. Dougal Drysdale, An Introduction to Fire Dynamics, 3rd edition, John Wiley & Sons, 2011

Reference books:
1. E.A. Johnson and K. Miyanishi, Forest Fires, Academic Press, San Diego, 2001.
2. Kevin McGrattan et al. Fire Dynamics Simulator, User’s Guide, NIST Special Publication 1019, 6th edition, NIST, 2017</td></tr>
</table>

	Journals: 1. Fire Safety Journal 2. Fire Technology 3. Combustion and Flame 4. International Journal of Wildland Fires

Subject Description Form

Subject Code	BSE6005
Subject Title	Indoor and Outdoor Environmental Quality Evaluation and Simulation
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Students should have basic knowledge of physics and mathematics.
Objectives	This subject aims to provide students with an in-depth understanding of the impact of indoor and outdoor environmental quality on building performance, in terms of air quality, lighting, acoustics, thermal and wind comfort and equip research students with advanced experimental and/or modeling skills for conducting indoor and outdoor environmental research. Students are expected to understand the role of human factors in indoor and outdoor environments and how building design can affect the indoor and outdoor environments, and how to make evaluation through site measurement, and computer simulation. The subject will also cover the latest building environmental assessment schemes, such as BEAM Plus and LEED. The students will be divided into groups to finish a group project which will include site measurement and computer simulation. The subject will include lecture, workshop, computer lab session, and seminar.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. understand the role of human factors in indoor and outdoor environmental performance and how building design can affect the indoor and outdoor environments. b. apply learned knowledge and skills in indoor and outdoor environmental research to conduct evaluation through site measurement, and computer simulation.
Subject Synopsis / Indicative Syllabus	This subject covers the following contents: **1. <u>Indoor environmental quality in relation to building design</u>** Introduction to thermal comfort, lighting, acoustics and indoor air quality including their definition, basic parameters, evaluation and simulation. Effects on human. Relationship between indoor environmental quality and building design. Examples. **2. <u>Outdoor environmental quality in relation to building design</u>** Introduction to outdoor environment in terms of acoustics (e.g. CRTN

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<tr><td></td><td>method), wind and thermal comfort (e.g. wind comfort criteria), air quality including definition, basic parameters, evaluation, prediction and simulation. Effects on human. Relationship between outdoor environment and building design. Examples.
3. <u>Rating of indoor and outdoor environmental performance</u>
BEAM Plus and LEED. Indoor environmental quality management strategies. Assessment of indoor and outdoor environment.</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>The students will be asked to conduct an individual project which will include site measurement and/or computer simulation. The subject will include lectures, workshops, computer lab session, and seminars.

Lectures: will introduce fundamental knowledge and theoretical basis for indoor and outdoor environments.

Workshops/seminars: Students are required to present and discuss key problems and potential issues for selected case studies.

Individual project: Students are required to prepare an individual report based on a specific indoor or outdoor environmental issues. Students are also required to give an oral presentation.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1. Coursework</td><td>60%</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2. Examination</td><td>40%</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>
</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>39 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>39 Hrs.</td></tr>
<tr><td>▪ Group project report</td><td>39 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>117 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>1. P.M. Bluyssen (2009) The Indoor Environmental Handbook. Earthscan.
2. BEAM Society. Building Environmental Assessment Method Plus – Existing Buildings.
3. BEAM Society. Building Environmental Assessment Method Plus – New Buildings.
4. M. Mehta, J Johnson and J Rocafort (1999). Architectural Acoustics, Principles and Design.
5. DiLaura DL, Houser KW, Mistrick RG, Steffy GR. 2011. The Lighting Handbook, 10th Edition. The Illuminating Engineering Society, New York, USA.</td></tr>
</table>

Subject Description Form

Subject Code	BSE6101
Subject Title	Research Seminar I
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	a. Understand the importance and strategic value of research and development. b. Develop effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per academic year, in addition to workshops/conferences, and to submit a record of seminars attended to the Chief Supervisor for endorsement. A report of no less than 1,500 words (excluding references) on one of the attended seminars every year is also required to be submitted to the Chief Supervisor for assessment. Part-time students are required to attend at least 10 research seminars per two academic years, in addition to workshops/conferences, and to submit a record of seminars attended to the Chief Supervisor for endorsement. A report of no less than 1,500 words (excluding references) on one of the attended seminars once every two years is also required to be submitted to the Chief Supervisor for assessment. The research seminars may or may not be organised by the Department of Building Environment and Energy Engineering and are expected to last not less than an hour each. Students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by a student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. Students should be awarded one credit per year (for full-time students) or per two years (for part-time students) for completing the research seminar credit requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, students are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students) to fulfill the above-mentioned requirement.

Subject Description Form

Subject Code	BSE6102
Subject Title	Research Seminar II
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	a. Understand the importance and strategic value of research and development. b. Develop effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per academic year, in addition to workshops/conferences, and to submit a record of seminars attended to the Chief Supervisor for endorsement. A report of no less than 1,500 words (excluding references) on one of the attended seminars every year is also required to be submitted to the Chief Supervisor for assessment. Part-time students are required to attend at least 10 research seminars per two academic years, in addition to workshops/conferences, and to submit a record of seminars attended to the Chief Supervisor for endorsement. A report of no less than 1,500 words (excluding references) on one of the attended seminars once every two years is also required to be submitted to the Chief Supervisor for assessment. The research seminars may or may not be organised by the Department of Building Environment and Energy Engineering and are expected to last not less than an hour each. Students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by a student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. Students should be awarded one credit per year (for full-time students) or per two years (for part-time students) for completing the research seminar credit requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, students are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students) to fulfill the above-mentioned requirement.

Subject Description Form

Subject Code	BSE6103
Subject Title	Research Seminar III
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	a. Understand the importance and strategic value of research and development. b. Develop effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per academic year, in addition to workshops/conferences, and to submit a record of seminars attended to the Chief Supervisor for endorsement. A report of no less than 1,500 words (excluding references) on one of the attended seminars every year is also required to be submitted to the Chief Supervisor for assessment. Part-time students are required to attend at least 10 research seminars per two academic years, in addition to workshops/conferences, and to submit a record of seminars attended to the Chief Supervisor for endorsement. A report of no less than 1,500 words (excluding references) on one of the attended seminars once every two years is also required to be submitted to the Chief Supervisor for assessment. The research seminars may or may not be organised by the Department of Building Environment and Energy Engineering and are expected to last not less than an hour each. Students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by a student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. Students should be awarded one credit per year (for full-time students) or per two years (for part-time students) for completing the research seminar credit requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, students are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students) to fulfill the above-mentioned requirement.

Subject Description Form

Subject Code	BSE6104
Subject Title	Research Seminar IV
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	a. Understand the importance and strategic value of research and development. b. Develop effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per academic year, in addition to workshops/conferences, and to submit a record of seminars attended to the Chief Supervisor for endorsement. A report of no less than 1,500 words (excluding references) on one of the attended seminars every year is also required to be submitted to the Chief Supervisor for assessment. Part-time students are required to attend at least 10 research seminars per two academic years, in addition to workshops/conferences, and to submit a record of seminars attended to the Chief Supervisor for endorsement. A report of no less than 1,500 words (excluding references) on one of the attended seminars once every two years is also required to be submitted to the Chief Supervisor for assessment. The research seminars may or may not be organised by the Department of Building Environment and Energy Engineering and are expected to last not less than an hour each. Students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by a student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. Students should be awarded one credit per year (for full-time students) or per two years (for part-time students) for completing the research seminar credit requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, students are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students) to fulfill the above-mentioned requirement.

Subject Description Form

Subject Code	BSE6105
Subject Title	Practicum I
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure of the students in teaching and academic supporting activities.
Intended Learning Outcomes	Develop effective teaching, communication and organisation skills.
Subject Synopsis / Indicative Syllabus	As part of the programme requirement, all PhD students who are not provided with the TPS Assistantship, irrespective of funding source and mode of study, must complete two training credits before graduation. To complete this subject, full-time students are required to engage in teaching/research supporting activities assigned by the Head of Department or his/her delegate for 6 hours/week in any 13-week semester. Part-time students are required to submit a report of no less than 1,500 words to the Chief Supervisor. The report should consist of the gains from their day-time job training, training nature, training period and number of hours involved. Students are required to complete this subject before submission of thesis. Subject to the approval of the Chief Supervisor, they can choose to complete this subject starting from their second year of study. For students who are required to undertake teaching supporting activities, they should be required to complete the training programmes organised by the EDC and ELC before the commencement of any teaching supporting activities.
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to: a) ensure that the activities are structured with proper assessment; and b) submit, at the end of the training session, an assessment report on the performance of the student, with details of activities undertaken and an overall grade of Pass or Fail.

Subject Description Form

Subject Code	BSE6106
Subject Title	Practicum II
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure of the students in teaching and academic supporting activities.
Intended Learning Outcomes	Develop effective teaching, communication and organisation skills.
Subject Synopsis / Indicative Syllabus	As part of the programme requirement, all PhD students who are not provided with the TPS Assistantship, irrespective of funding source and mode of study, must complete two training credits before graduation. To complete this subject, full-time students are required to engage in teaching/research supporting activities assigned by the Head of Department or his/her delegate for 6 hours/week in any 13-week semester. Part-time students are required to submit a report of no less than 1,500 words to the Chief Supervisor. The report should consist of the gains from their day-time job training, training nature, training period and number of hours involved. Students are required to complete this subject before submission of thesis. Subject to the approval of the Chief Supervisor, they can choose to complete this subject starting from their second year of study. For students who are required to undertake teaching supporting activities, they should be required to complete the training programmes organised by the EDC and ELC before the commencement of any teaching supporting activities.
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to: c) ensure that the activities are structured with proper assessment; and d) submit, at the end of the training session, an assessment report on the performance of the student, with details of activities undertaken and an overall grade of Pass or Fail.

Departmental Subjects

***B**uilding and **R**eal **E**state*

Subject Description Form

Subject Code	BRE612
Subject Title	Productivity in Construction
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This course provides an overview of quantitative methods used to assess and analysis labor and equipment productivity in construction operations. The students will study various types of equipment including earth moving equipment (excavators, loaders, dozers, scrapers, trucks, etc.); cranes; mixing, transporting, and placing concrete; piling; paving; tunnelling; etc. Innovative and smart methods used to monitor and select the appropriate equipment, its optimal number, capacity and location. Labor productivity will cover the examination of its definitions, what it measures, why it is important, how it affects the total economy, and the main factors affecting its growth. The students will study how to calculate labor productivity, understand the importance of measuring labor productivity, and policies to improve labor productivity, in terms of investment in physical capital, quality of education and training, and technological progress.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) Understand the fundamentals of labor and equipment productivity assessment. (b) Identify and study the different factors that impact labor and equipment productivity in construction. (c) Understand the techniques of data analysis and modelling in labor and equipment productivity. (d) Apply knowledge of labor and equipment productivity to construction projects. (e) Communicate with others in a clear and articulated manner. (f) Identify and propose solutions to construction productivity and presentation problems. (g) Identify and study the appropriateness, advantages, and limitations of various types of labors and equipment for different construction problems.
Subject Synopsis / Indicative Syllabus	The subject will cover the following content: **Equipment Productivity:** a brief initial introduction to equipment productivity, factors that affect various types of construction equipment, discussion of productivity modeling, assumptions, and limitations in construction applications. The students will also study various types of equipment including earth moving equipment (excavators, loaders, dozers,

<table>
<tr><td></td><td>scrapers, trucks, etc.); cranes; mixing, transporting, and placing concrete; piling; paving; tunnelling; etc. This part will also discuss the innovative and smart methods used to monitor and select the appropriate equipment, its optimal number, capacity and location.

Labor Productivity: introduction to the principles of modeling labor productivity and its application to construction activities, examination of productivity definitions, what it measures, why it is important, how it affects the total economy, and the main factors affecting its growth. The students will study how to calculate labor productivity, understand the importance of measuring labor productivity, and policies to improve productivity, in terms of investment in physical capital, quality of education and training, and technological progress. Specific emphasis will be placed on modeling labor productivity in heavy and highway construction, underground and tunnelling construction, and building construction.</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>The course includes a combination of lectures, assigned readings, quizzes, a series of weekly individual assignments, and a class project (term project) for modeling and analyzing actual labor and equipment productivity in construction operations in addition to two exams.

The lectures aim to provide the students fundamental concepts and principles of advanced productivity assessment to solve construction problems. Assigned readings from literature will guide students to better understand the discussed materials through active learning approach. Assignments will improve the problem solving skills for students. Students will be asked to complete a term project on their topic of interest.</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="7">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td><td>g</td></tr>
<tr><td>1. Quiz</td><td>10%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>2. Project</td><td>30%</td><td></td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>3. Examination</td><td>60%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100%</td><td colspan="7"></td></tr>
</table>
Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Assessment is divided into three parts individual quizzes (10%), group projects (30%), and individual examinations (60%). Quizzes and examinations will test the students understanding of fundamental knowledge of productivity in construction, factors that impact productivity, and research techniques for modeling and analysis of productivity.

Students will be divided into groups to model, analyze and implement the gained knowledge on productivity to a real case study(ies). The project requires the students to work in a team where learning outcomes are</td></tr>
</table>

	assessed by means of group presentations and reports. Communication skills will be tested during the project work and presentation.	
Student Study Effort Expected	Class contact:	
	▪ Lectures	39 Hrs.
	▪ Project Seminars	11 Hrs.
	Other student study effort:	
	▪ Reading of reference materials	46 Hrs.
	▪ Writing project report	24 Hrs.
	Total student study effort	120 Hrs.
Reading List and References	• Nunnally, S.W. (2010). Construction Methods and Management. 8th Ed., Pearson Education Inc., Upper Saddle River, New Jersey, USA. • Bernold, L.E. (2013). Construction Equipment and Methods: Planning, Innovation, Safety. John Wiley & Sons Ltd, New York, NY, USA. • Peurifoy, R., Schexnayder, C., Shapira, A., and Schmitt, R. (2010). Construction Planning, Equipment, and Methods. 8th Edition. McGraw-Hill Education, New York, NY, USA. • Halpin, Daniel W. and Riggs, Leland S. (1992). Planning and Analysis of Construction Operations. John Wiley & Sons, New York, NY. • Elwakil, E. and Zayed, T. (2018). "Construction Productivity Fuzzy Knowledge Base Management System," Canadian Journal of Civil Eng., January 06, 45(5):329-338. • Jabri, A. and Zayed, T. (2017). "Agent-based modeling and simulation of earthmoving operations," J. of Automation in Construction, September, 81: 210-223. • Mirahadi, F. and Zayed, T. (2016). "Simulation-Based Construction Productivity Forecast Using Neural-Network-Driven Fuzzy Reasoning," J. of Automation in Construction, May, Vol. 65, pp. 102-115. • Alzraiee, H., Zayed, T., and Moselhi, O. (2015). "Dynamic Planning of Construction Activities using Hybrid Simulation," J. of Automation in Construction, Volume 49, Part B, Jan, PP. 176-192. • Zayed, T. and Mohamed, E. (2014). "A Case Productivity Model for Automatic Climbing System," J. of Eng., Construction and Architectural Management, Jan., 21(1): 33-50. • Zayed, T. (2009). "Stochastic Productivity Assessment of Continuous Flight Auger Piles," J. of Architectural Science Review (ASR), Australia, March, 52(1): 13-23. • Zhang, C., Zayed, T., and Hammad, A. (2008). "Resource Mgmt of Bridge Deck Rehabilitation: Jacques Cartier Bridge Case Study," J. of Construction Eng. & Mgmt, ASCE, May, 134(5): 311-319. • Zayed, T. and Halpin, D. (2004). "Simulation as a Tool for piles Productivity Assessment," J. of Construction Eng and Mgmt, ASCE, May/June, 130(3): 394-404. • Zayed, T. and Halpin, D. (2001). "Simulation of Concrete Batch Plant Production," J. of Construction Eng. and Management, ASCE, April, 127(2): 132-141. • Yi, W, and Chan, APC (2017) Effects of heat stress on construction labor productivity in Hong Kong: a case study of rebar workers. International Journal of Environmental Research and Public Health, Volume 14, Issue 9, 12 September 2017, Article number 1055, doi:10.3390/ijerph14091055 • Yi, W, and Chan, APC (2015) Optimal work pattern for construction workers	

	in hot weather: a case study in Hong Kong. ASCE's Journal of Computing in Civil Engineering. http://dx.doi.org/10.1061/(ASCE)CP.1943-5487.0000419 (Accepted on 2 June 2014, published online on July 8, 2014), 05014009-1-11, Vol.29, Issue 5, 1 September 2015. • Yi, W, and Chan, APC (2014) Critical review of labor productivity research in construction journals. Journal of Management in Engineering, doi:10.1061/(ASCE)ME.1943-5479.0000194, Vol.30, No.2, March 1, 2014, 214-225. • Yi, W, and Chan, APC (2013) Optimizing work-rest schedule for construction rebar workers in hot and humid environment. Building and Environment 61(2013) 104-113. • Chan, APC, Wong, FKW, Wong, DP, Lam EWM, and Yi, W (2012) Determining an optimal recovery time after exercising to exhaustion in a controlled climatic environment: application to construction works. Journal of Building and Environment, 56 (2012) 28-37. • Yi, W, and Chan, APC (2015) An artificial neural network model for predicting fatigue of construction workers in humid environments. 8th International Structural Engineering and Construction Conference (ISEC-08), Western Sydney University, November 2015 • Wong, JWM, Chan, APC, and Chiang, YH (2011) Construction manpower demand forecasting: a comparative study of univariate time series, multiple regression and econometric modeling techniques. Journal of Engineering, Construction and Architectural Management, Vol.18, Issue 1, 1-29. • Wong, JWM, Chan, APC, and Chiang, YH (2010) Modelling construction occupational demand: the case of Hong Kong. ASCE Journal Construction Engineering and Management, Vol. 136, No. 9, September 1, 2010, 991-1002. • Chan, APC, Wong, JWM, Chiang, YH (2004) Modelling Labour Demand at Project Level – An Empirical Study in Hong Kong, the Journal of Engineering, Design and Technology, Vol. 1, No.2, 135-150. • Chan, DWM, Chan, APC, Lam, PTI, and Lau, WK (2015) Predicting construction durations and enhancing construction productivity: a taxonomic review. Innovation in Construction, Research Journal 2015, Issue 2, 31-44. • Chan, APC, and Chan, DWM (2003) A benchmark model for construction duration in public housing developments, International Journal of Construction Management, Vol.3, No.1, 1-14. • Chan, APC, and Chan, DWM (2003) A research framework for benchmarking project construction durations, Construction Information Quarterly, The Chartered Institute of Building, Vol. 5, Issue 2, 10-15. • Chan, APC (1999) Modelling building durations in Hong Kong. The Journal of Construction Management and Economics, Volume 17, Number 2, March, 1999, 189-196. • Chan, APC and Chan, DWM (2004) Developing a benchmark model for project construction time performance in Hong Kong, Building and Environment, Vol.39, March, 339-249. • Chan, APC (2001) Time cost relationship of public sector projects in Malaysia, International Journal of Project Management, Vol. 19, No.4, 223-229.

Subject Description Form

Subject Code	BRE666
Subject Title	Numerical Methods for Engineers
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject aims to provide students the basic concepts, methodologies and skills of solving engineering problems numerically with computers.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. find the root of an equation by bisection method and Newton-Raphson method; b. solve algebraic equations by Gauss elimination, LU decomposition and matrix inversion, Gauss-Seidel iteration method; c. apply least-squares regression and interpolating polynomials for curve-fitting and plotting experimental data; d. apply Newton-Cotes integration formulas for numerical integration and finite difference method for numerical differentiation; e. apply finite difference methods for solving ordinary and partial differential equations, including Euler's method, Runge-Kutta method, and Crank-Nicolson method. f. Apply statistical methods for data analysis
Subject Synopsis / Indicative Syllabus	**Introduction to Numerical and Statistical Methods** **Roots of non-linear equations** – Bracketing method. Bisection method. Open methods. Newton-Raphson method. Secant method. Brent's method. **Linear algebraic equation**s – Gauss elimination. LU Decomposition and Matrix Inversion. Gauss-seidel iteration. **Curve fitting and interpolating** – Least square regression. Linear regression. Polynomial regression. Nonlinear regression. Interpolation. Lagrange interpolating polynomials. Newton's divided-difference interpolating polynomials. Spline interpolation. **Numerical integration and differentiation** – Newton-cotes integration formulas. Trapezoidal rule. Simpson's rules. Romberg integration.

<table>
<tr><td></td><td>Taylor’s series expansion. Richardson extrapolation.

Differential equations – Euler’s method. Runge-Kutta method. Systems of equations. General methods for boundary-value problems. The shooting method. Finite difference method; Explicit methods. Crank-Nicolson method. Alternating-direction implicit (ADI) scheme.

Statistical methods for Building Engineers, Surveyors and Project Managers – Elementary measurements of central tendency and dispersions; Probability and probability distributions; Collection of data, sampling, sampling distributions estimation and hypothesis testing; Goodness of fit and testing of independence simple and multiple regression;

Software application: SPSS</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>Teaching periods will adopt a range of methods which include lectures and tutorials. The lectures aim to provide the students fundamental concepts and principles of numerical methods. Tutorial will be used to develop students’ problem solving skills. Where appropriate, the use of computer assisted learning techniques will be employed.
The intention is to create an environment that encourages active learning. Students will be encouraged to apply the numerical techniques to solve practical engineering problems.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td></tr>
<tr><td>1. Coursework</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>2. Examination</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>
Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:
Examination and coursework will constitute 50% and 50% of the overall work of the subject respectively. The coursework mark will be based on the assessments of assignments, problem solving projects, and in-class mid-term test. Assessment methods are intended to ensure the students achieve the learning objectives.</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures</td><td>2 x 13 = 26 Hrs.</td></tr>
<tr><td>▪ Tutorials</td><td>1 X 13 = 13 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Computer simulations and results analysis</td><td>6 x 7 = 42 Hrs.</td></tr>
<tr><td>▪ Self-study</td><td>3 x 13 = 39 Hrs.</td></tr>
</table>
</td></tr>
</table>

	Total student study effort	120 Hrs.
Reading List and References	1. S.C. Chapra and R.R. Canale, Numerical Methods for Enginers, McGraw-Hill, 2006. 2. J. Kiusalaas, Numerical Methods in Engineering with MATLAB, Cambridge University Press, 2010. 3. W. Dos Passos, Numerical methods, algorithms, and tools in C#, CRC press, 2010. 4. D.R. Durran, Numerical Methods for Fluid Dynamics: with Applications to Geophysics, New York, Springer, 2010. 5. D.F. Griffiths, D.J. Higham, Numerical Methods for Ordinary Differential Equations: Initial Value Problems, London, New York, Springer, 2010. 6. B.C. Cronk, *How to use SPSS: a step-by-step guide to analysis and interpretation.* Pyrczak Publishing, 2008 7. Francis Bacon in *Stanford Encyclopedia of Philosophy*. Edited by Zalta, E.N. 8. D.B. Levine, D.F. Stephan, T.C. Krehbiel, M.L. Berenson, *Statistics for Managers using Microsoft Excel*. Pearson. 2011. 9. D.P. Lindstrom (ed.) *Schaum's easy outlines in statistics*. McGraw Hill. 2002. 10. E.M. Phillips, D.S. Pugh, *How to get a PhD*. Open University Press. 2010. 11. K.R. Popper, *The logic of scientific discovery*. Hutchinson. 1968.	

Subject Description Form

Subject Code	BRE671
Subject Title	Attendance in research seminars/workshops/conferences
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	Understand the importance and strategic value of research and development. Develop effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per academic year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two academic years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two academic years. The research seminars may or may not be organised by BRE Department and are expected to last not less than an hour each. RPg students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. The Chief Supervisor has to pass the record of the seminars attended by their students and the report with a pass grade to the Research Office for custody at the end of each academic year. Students are recommended to complete one credit for attending seminars per year (for full-time students) or per two years (for part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students to fulfil the research seminar credit requirement.

Subject Description Form

Subject Code	BRE672
Subject Title	Attendance in research seminars/workshops/conferences
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	Understand the importance and strategic value of research and development. Develop effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per academic year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two academic years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two academic years. The research seminars may or may not be organised by BRE Department and are expected to last not less than an hour each. RPg students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. The Chief Supervisor has to pass the record of the seminars attended by their students and the report with a pass grade to the Research Office for custody at the end of each academic year. Students are recommended to complete one credit for attending seminars per year (for full-time students) or per two years (for part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students to fulfil the research seminar credit requirement.

Subject Description Form

Subject Code	BRE673
Subject Title	Attendance in research seminars/workshops/conferences
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	Understand the importance and strategic value of research and development. Develop effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per academic year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two academic years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two academic years. The research seminars may or may not be organised by BRE Department and are expected to last not less than an hour each. RPg students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. The Chief Supervisor has to pass the record of the seminars attended by their students and the report with a pass grade to the Research Office for custody at the end of each academic year. Students are recommended to complete one credit for attending seminars per year (for full-time students) or per two years (for part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students to fulfil the research seminar credit requirement.

Subject Description Form

Subject Code	BRE674
Subject Title	Attendance in research seminars/workshops/conferences
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	Understand the importance and strategic value of research and development. Develop effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per academic year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two academic years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two academic years. The research seminars may or may not be organised by BRE Department and are expected to last not less than an hour each. RPg students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. The Chief Supervisor has to pass the record of the seminars attended by their students and the report with a pass grade to the Research Office for custody at the end of each academic year. Students are recommended to complete one credit for attending seminars per year (for full-time students) or per two years (for part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students to fulfil the research seminar credit requirement.

Subject Description Form

Subject Code	BRE675
Subject Title	Practicum
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure of the students in teaching activities and professional service.
Intended Learning Outcomes	Develop effective teaching, communication and organisation skills.
Subject Synopsis / Indicative Syllabus	As part of the programme requirement, all PhD students who are not provided with the TPS Assistantship, irrespective of funding source and mode of study, must complete two training credits before graduation. To earn one credit, students will be required to engage in teaching activities and/or professional service recognized by the Department. Students are allowed to complete these two credits any time before they graduate. They can choose to complete these two credits in two different semesters or within the same semester, subject to the approval of the Chief Supervisor. For students who are required to undertake teaching supporting activities, they should be required to complete the training programmes organised by the EDC and ELC before the commencement of any teaching supporting activities.
Assessment Methods	Chief Supervisors are required to: a. Ensure that the activities are structured with proper assessment and b. Submit an assessment report on the performance of the student, with details of activities undertaken and an overall grade of Pass or Fail.

Subject Description Form

Subject Code	BRE676
Subject Title	Practicum
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	To enhance the exposure of the students in teaching activities and professional service.
Intended Learning Outcomes	Develop effective teaching, communication and organisation skills.
Subject Synopsis / Indicative Syllabus	As part of the programme requirement, all PhD students who are not provided with the TPS Assistantship, irrespective of funding source and mode of study, must complete two training credits before graduation. To earn one credit, students will be required to engage in teaching activities and/or professional service recognized by the Department. Students are allowed to complete these two credits any time before they graduate. They can choose to complete these two credits in two different semesters or within the same semester, subject to the approval of the Chief Supervisor. For students who are required to undertake teaching supporting activities, they should be required to complete the training programmes organised by the EDC and ELC before the commencement of any teaching supporting activities.
Assessment Methods	Chief Supervisors are required to: a. Ensure that the activities are structured with proper assessment and b. Submit an assessment report on the performance of the student, with details of activities undertaken and an overall grade of Pass or Fail.

Departmental Subjects

***C**ivil and **E**nvironmental **E**ngineering*

Subject Description Form

Subject Code	CSE6010
Subject Title	Nonlinear Finite Element Analysis of Structures
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Students should possess a basic understanding of elasticity, plasticity, and linear finite element analysis of structures from first courses on these topics or through self-learning
Objectives	This subject is intended to (a) Expose students to common geometrically and materially nonlinear phenomena of civil engineering structures; (b) Equip students with a good understanding of plasticity-based constitutive modelling for steel and other materials; and (c) Provide students with a good knowledge of the concepts and techniques of the finite element method as employed in the nonlinear numerical analysis of structures under static and dynamic loads.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Develop finite element models for static and dynamic problems; b. Explain clearly the stress-strain-strength of metals, concrete, rock and soils and their constitutive modeling; c. Explain clearly geometric nonlinearity and its modelling techniques; d. Conduct reliable and efficient static or dynamic nonlinear finite element analyses using a general-purpose package by informed choices of element types, boundary conditions, constitutive models, solution procedures, etc.; e. Interpret and evaluate results from nonlinear finite element analyses in a sensible manner.
Subject Synopsis / Indicative Syllabus	This subject covers the following aspects: 1. <u>Review of fundamental concepts of finite element method</u> Finite element formulation by Weighted Residual Method; Iso-parametric formulation, Numerical integration; Solution by frontal solver; Solution of eigenvalue problems; Method of sub-space iterations; Types of elements. 2. <u>Geometric nonlinearity</u> Finite element vs stability function; Element with initial

imperfection for second-order analysis; Newton Raphson Method; Displacement control method for tracing of equilibrium path; Snap-through and snap-back buckling. Second-order direct analysis applied to structural design.

3. Material nonlinearity and constitutive models for metals

Elastic-plastic behavior of metals; Yield surfaces; Flow theory of plasticity; Associated versus non-associated plasticity; Tresca model; Von Mises model; Incremental stress-strain relationships; Tangent stiffness matrix; Brief introduction to finite element programs for solids.

4. Constitutive models for concrete

Elastic-plastic behaviour of concrete; Yield surfaces for concrete; Rate effects; Drucker-Prager model; Mohr-Coulomb model; Plastic-damage model.

5. Dynamic nonlinear analysis of structures

Linear dynamics: Equations of motion; Mass matrix (lumped mass, consistent mass); Damping matrix (Rayleigh damping and modal damping); Central difference method; Newmark's method. Nonlinear dynamics: Incremental equations of motion; Computational errors. Seismic analysis: Ground motion; Seismic equations of motion; Response spectrum; Ductility demand; Capacity spectrum; Incremental dynamic analysis.

Teaching / Learning Methodology

The subject is delivered mainly through lectures focused on the theory and techniques of nonlinear finite element analysis of structures. The lectures need to be supplemented by substantial self-study after class by students of reference materials recommended by subject lecturers.

Students need to each complete a set of assignments on small numerical modeling problems. Each student also needs to undertake a numerical modeling project using a general-purpose finite element package. These modeling exercises will provide students with hands-on experience and opprotunities to put theory into practice.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed					
		a	b	c	d	e	
1. Assignments	30%	✓	✓	✓	✓		
2. Project report	30%				✓	✓	

	3. Quiz	20%	✓	✓	✓			
	4. Oral Examination	20%				✓	✓	
	Total	100%						

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

The assignments are used mainly to assess the mastery of skills for developing finite element models [learning outcome (a)], for explaining material and geometric nonlinearity [learning outcomes (b) and (c)] for conducting nonlinear finite element analysis using a general-purpose finite element package [learning outcome (d)]. The in-class quizzes are used to assess learning outcomes (a), (b) and (c). The numerical modeling project, requiring the integration of skills to solve a more sophisticated physical problem using a general-purpose FE package, is an assessment that covers learning outcomes (d), and (e). The oral examination, consisting of the oral presentation of a project and a question & answer session, is for the assessment of learning outcomes (d) and (e).

Student Study Effort Expected		
	Class contact:	
	▪ Lecture	39 Hrs.
	▪ Examination	
	Other student study effort:	
	▪ Reading of reference materials	26 Hrs.
	▪ Assignments on small modeling problems	30 Hrs.
	▪ Numerical modeling project	40 Hrs.
	Total student study effort	135 Hrs.

Reading List and References

1. Books

- Bhatti, M.A. (2006). Advanced topics in finite element analysis of structures: with Mathematics and Matlab Computations. John Wiley & Sons, Inc. New York.
- Barbero, E.J. (2013) Finite element analysis of composite materials using ABAQUS, CRC Press/Taylor & Francis Group.
- Chen, W.F. and Han, D.J. (1988). Plasticity for structural engineers. Springer-Verlag, New York.
- Chopra, A.K. (2001) Dynamics of structures: theory and applications to earthquake engineering, Prentice Hall.
- Clough, R.W. and Penzien, J. (1993) Dynamics of structures. McGraw-Hill Education.
- Cook, R.D. (1995) Finite element modeling for stress analysis, John Wiley & Sons.
- De Borst, R. Crisfield, M.A., Remmers, J.J.C. and Verhoosel, C.V. (2012) Nonlinear finite element analysis of solids and structures, 2nd

	edition, Wiley. • Guven, I. (2006) The finite element method and applications in engineering using ANSYS, Springer. • Khennane, A. (2013) Introduction to finite element analysis using MATLAB and ABAQUS, CRC Press/Taylor & Francis Group. • Kythe, P. and Wei, D. (2004) An introduction to linear and nonlinear finite element analysis: a computation approach, Birkhauser Publisher. • Reedy, J.N. (2004) An introduction to nonlinear finite element analysis. Oxford University Press. • Smith, I.M. and Griffiths D.V. (1988), Programming the finite element method, John Wiley, 3rd edition. • Zienkiewicz, O.C. (1977) The finite element method, 3rd edition, McGraw-Hill. **2. Finite Element Software Available in the CEE Computer Room** • ANSYS, from ANSYS Inc, Pittsburgh, USA. • ABAQUS FEA, from Dassault Systèmes Simulia Corp, Rhode Island, USA. • NIDA, Nonlinear Integrated Design and Analysis, PolyU.

Subject Description Form

Subject Code	CSE6011
Subject Title	Structural Performance Monitoring
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Structural dynamics
Objectives	(1) To expose students to the new and innovative health monitoring technology for sustainable infrastructure; (2) To develop an understanding of the basic theory and practical use of health monitoring systems and technology; and (3) To enable students to design and implement health monitoring technology for sustainable infrastructure.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. design appropriate and cost-effective health monitoring systems for sustainable infrastructure; b. process and interpret various types of data from a structural health monitoring system; c. evaluate structural performance based on analyzed data and other information; and d. provide the findings for the client, designer, contractor, or other relevant sectors on the safety and sustainability of the infrastructure through oral presentations and written reports.
Subject Synopsis / Indicative Syllabus	1. Introduction (1.5 weeks) Infrastructure, built environment, safety, sustainability, recent developments in health monitoring technology 2. Health monitoring system (1.5 weeks) Sensors and sensing technology, data acquisition and transmission system, data processing and control, data management system, design of health monitoring system 3. Finite element modeling (1 week) Beam model, solid model, hybrid model, model updating 4. Structural dynamics and testing (2 weeks) Basic of structural dynamics, modal testing and modal analysis 5. Monitoring of structural loadings and effects (3 weeks)

<table>
<tr><td></td><td>Traffic load, temperature load, wind load, other loads

6. Structural damage detection (1 week)
Vibration based methods, non-destructive testing methods

7. Project works (3 weeks)
Analysis of data from a health monitoring system or laboratory testing on a test-bed, written report, oral presentation.</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>Fundamental knowledge related to health monitoring of infrastructure for safety and sustainability will be presented in lectures. Real applications to some landmark infrastructure will be demonstrated in details. Assignments will help students consolidate their understanding and implementation of commonly used data processing techniques. Laboratory testing on a test-bed and real practice on some structural health monitoring systems will help students to understand the basic methods used in structural health monitoring and the challenges for the real infrastructure. Final oral presentation will train the students on presentation and communication skills.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td></td><td></td></tr>
<tr><td>1. Assignments</td><td>30%</td><td></td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>2. Project report</td><td>40%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>3. Project presentation</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>
</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures/Tutorials</td><td>30 Hrs.</td></tr>
<tr><td>▪ Project/Laboratory/Presentation</td><td>9 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading and studying</td><td>48 Hrs.</td></tr>
<tr><td>▪ Completion of reports</td><td>30 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>117 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>Books
1) Xu, Y.L. and Xia, Y., (2011), Structural Health Monitoring of Long Span Suspension Bridges, Spon Press.
2) Boller, C., Chang, F.K. and Fujino, Y., 2009, Encyclopedia of Structural Health Monitoring, (Chichester: John Wiley & Sons).
3) Clough, R.W. and Penzien, J., 1993, Dynamics of Structure, 2nd edition, (New York: McGraw-Hill).
4) FHA, 2006, Bridge Inspector's Reference Manual, (Federal Highway Administration).
5) Friswell, M.I. and Mottershead, J.E., 1995, Finite Element Model Updating in Structural Dynamics, (Boston: Kluwer Academic Publishers).
6) Frýba, L. 1996, Dynamics of Railway Bridges, (Thomas Telford House).</td></tr>
</table>

7) Gimsing, N.J., 1997, *Cable Supported Bridges: Concept and Design,* 2nd ed., (New York: Chichester).
8) Hellier, C.J., 2001, *Handbook of Nondestructive Evaluation,* (USA: McGraw-Hill).
9) Karbhari, V.M. and Ansari, F., 2009, *Structural Health Monitoring of Civil Infrastructure Systems,* (Cambridge: Woodhead Publishing Limited).
10) Maia, N.M.M., Silva, J.M.M., He, J., Lieven, N.A.J., Lin, R.M., Skingle, G.W., To, W., and Urgueira, A.P.V., 1997, *Theoretical and Experimental Modal Analysis,* (England: Research Studies Press Ltd).
11) Mufti, A., 2001, *Guidelines for Structural Health Monitoring,* (Winnipeg: Intelligent Sensing for Innovative Structures).
12) Rohsenow, W.M., 1988, *Handbook of Heat Transfer Applications,* (New York: McGraw-Hill).
13) Zienjiewicz, O.C. and Taylor, R.L., 1994, *The Finite Element Method, Vol. 1: Basic Formulation and Linear Problems,* 4th ed., England, (Berkshire: McGraw-Hill).

Papers and reports

14) Blejwas, T.E., Feng, C.C., and Ayre, R.S., 1979, Dynamic interaction of moving vehicles and structures. *Journal of Sound and Vibration,* 67, pp.513-521.
15) Brownjohn, J.M.W., 2007, Structural health monitoring of civil infrastructure. *Philosophical Transactions of the Royal Society A,* 365 (1851), pp. 589-622.
16) Consolazio, G.R., Cook, R.A., McVay, M.C., Cowan, D.R. and Biggs, A.E., 2006, *Barge Impact Testing of the St. George Island Causeway Bridge, Phase III: Physical Testing and Data Interpretation,* Structural Research Report No. BC-354-RPWO-76, University of Florida.
17) Deng, L. and Cai, C.s., 2010, Bridge sour: prediction, modeling, monitoring, and countermeasures – review. *Practice Periodical on Structural Design and Construction,* ASCE, 15(2), pp. 125-134.
18) Doebling, S.W., Farrar, C R, Prime, M.B and Shevitz, D.W, 1996, *Damage Identification and Health Monitoring of Structural and Mechanical Systems from Changes in their Vibration Characteristics: A Literature Review,* Los Alamos National Laboratory Report LA-13070-MS.
19) Kareem, A., 2008, Numerical simulation of wind effects: A probabilistic perspective. *Journal of Wind Engineering and Industrial Aerodynamics,* 96(10-11), pp.1472-1497.
20) Ko J.M. and Ni Y.Q., 2005, Technology developments in structural health monitoring of large-scale bridges. *Engineering Structures, ASCE,* 27, pp. 1715-1725.
21) Ni, Y.Q., Xia, Y., Liao, W.Y. and Ko, J.M., (2009), "Technology Innovation in Developing the Structural Health Monitoring System for Guangzhou New TV Tower", *Structural Control and Health Monitoring,* 16(1), 73-98.
22) Song, H.W. and Saraswathy, V., 2007, Corrosion monitoring of reinforced concrete structures – a review. *International Journal of Electrochemical Science,* 2, pp. 1-28.
23) Xu, Y.L., 2008, Making good use of structural health monitoring systems: Hong Kong's Experience. In *Proceedings of The Second International Forum on Advances in Structural Engineering, Structural Disaster Prevention, Monitoring and Control,* Dalian, China, pp. 159-198.

Subject Description Form

Subject Code	CSE6012
Subject Title	Advances in Geotechnical and Pavement Engineering
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Recommended background knowledge: Students should have a knowledge and understanding of engineering mathematics, engineering mechanics, soil mechanics, and foundation engineering consistent with undergraduate level study in civil engineering.
Objectives	1. To provide students with the knowledge about the fundamental properties and behaviour of earth materials, mathematical models, and methods of analysis for different conditions. 2. To provide students with in-depth analysis and design of common geotechnical structures and solutions to real problems. 3. To provide students with practical knowledge of pavement material and pavement behavioural analysis
Intended Learning Outcomes	Upon completion of the subject, students will be able: a. to apply the knowledge about the behaviour of earth materials and their constitutive models in geotechnical analyses; b. to apply advanced pavement knowledge in design and analysis of pavements c. to perform critical thinking on design methods and solutions; and d. to understand the performance of geotechnical structures.
Subject Synopsis / Indicative Syllabus	**Keyword Syllabus** i) Geotechnical testing and soil behaviour (2.5 weeks) Conventional and advanced lab/field testing in geotechnics, Introduction to centrifuge modelling and particle image velocimetry, Mechanical behavior of soils. ii) Constitutive modeling of soils (2.5 weeks) Introduction of elasticity and plasticity; Nonlinear stress dependent elastic model; Mohr-Coulomb model; Cam-clay and Modified Cam-clay models; advances of soil modeling. iii) Advances in geotechnical applications (2 weeks) Advances in slope stability analysis, foundation (pile group/piled raft) analysis, Uncertainty and reliability approaches in geotechnical

<table>
<tr><td></td><td>engineering.

iv) <u>Pavement structure and materials (1 week)</u>
Introduction to pavement type and structure; rheological properties and characterization of bitumen and bituminous materials.

v) <u>Mechanical models of bituminous pavements (3 weeks)</u>
Mechanical models of bituminous mixtures; pavement temperature prediction; dynamic traffic loads, pavement responses and distress evolution.

vi) <u>Pavement condition and evaluation (2 weeks)</u>
Pavement functional properties; pavement structural properties; non-destructive pavement evaluation techniques, such as falling weight deflectometer and ground penetration radar.</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>1. Lectures to deliver teaching materials.
2. Journal papers on new methods, advanced techniques or basic theory.
3. Assignments related to the subject contents.
4. Project reports</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td></td><td></td></tr>
<tr><td>1. Continuous Assignment</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Individual report on a special study topic</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>
Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Continuous assessment is based on assignment/quiz/test/project paper for all lectures (50%).
Each student shall submit an individual report on a special study topic which will be given by a lecturer in his field (50%).
Students must attain at least Grade D in the coursework and continuous assessment in order to attain a passing grade in the overall result.</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures</td><td>39 Hrs.</td></tr>
<tr><td>▪ Examination</td><td>--</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>36 Hrs.</td></tr>
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</table>

	▪ Assignments	30 Hrs.
	▪ Project	30 Hrs.
	Total student study effort	135 Hrs.
Reading List and References	**Books** • Chau, K.T. (2013) Analytic Methods in Geomechanics, CRC Press, Boca Raton. • Chen, W.F., *Limit Analysis and Soil Plasticity,* Elsevier, (1975). • Cheng Y.M. and Lau C.K., *Soil Slope Stability Analysis and Stabilization – New methods and insights,* 2nd edition, Francis & Taylors (2014). • Fleming, Weltman, Randolph and Elson, Piling Engineering, 3rd edition, Taylors and Francis (2009). • Muir Wood, David, "Soil Behaviour and Critical State Soil Mechanics", Cambridge University Press, (1990) • Potts, D.M. and Zdravkovic, L. Finite Element Analysis in Geotechnical Engineering – Theory, Thomas Telford Publishing Ltd, U.K. (ISBN 0 7277 2753 2), (1999). • Shukla, Sanjay Kumar and Jian-Hua Yin (2006). "Fundamentals of Geosynthetic Engineering", published by A.A. Balkema Publishers Taylor & Francis, The Netherlands. (450 pages, 239 illustrations, 42 tables, ISBN 0415 39444 9). • Achenbach, J.D. Wave Propagation in Elastic Solids. North-Holland (1987). Huang Y. H. 2003. Pavement Analysis and Design, 2nd edition. Pearson Prentice Hall, Upper Saddle River, NJ. • Roberts, Freddy L., Prithvi S. Kandhal, E. Ray Brown, Dah-Yinn Lee, and Thomas W. Kennedy. "Hot Mix Asphalt Materials, Mixture Design and Construction." (1996). • AI-Qadi, I.L. and S. Lahouar, "Measuring Layer Thickness with GPR-Theory to Practice," Construction and Building Materials, Vol. 19, 2005, pp. 763-772. • Lytton, R.L., "Back calculation of Pavement Layer Properties", Nondestructive Testing of Pavement and Back calculation of Moduli, American Society of Testing and Materials Standard Technical Publication 1026, A.J. Bush III and G.Y. Baladi, Eds., Philadelphia, PA, 1989, pp. 7-38. **Journals** • Canadian Geotechnical Journal • Computers and Geotechnics • Geotechnique • Journal of Geotechnical and Geoenvironmental Engineering, The American Society of Civil Engineers • Soils and Foundations • Rock Mechanics and Rock Engineering • International Journal of Rock Mechanics and Mining Sciences • International Journal of Pavement Engineering	

	• Transportation Research Record **<u>Manuals</u>** • Guide to Retaining Wall Construction (1993), Geotechnical Control Office, (GEO), Hong Kong Government. • Review of Design Methods for Excavations (1990), Geotechnical Control Office (GEO), Hong Kong Government. • Foundation Design and Construction, GEO Publication No. 1/2006, Geotechnical Control Office, (GEO), Hong Kong Government. • Hong Kong Foundation Handbook, Housing Department, 2011, Hong Kong Housing Authority.

Subject Description Form

Subject Code	CSE6013
Subject Title	Life Cycle Performance Management of Concrete Infrastructure
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Students should have fundamental knowledge about concrete materials and design of concrete structures.
Objectives	This subject is intended to (a) Provide students with holistic understanding of the life cycle performance management strategy of concrete infrastructure; (b) Equip students with a good understanding of various deterioration mechanisms of concrete materials and reinforced concrete structures under mechanical and environmental actions; (c) Equip students with knowledge about the inspection and diagnosis of various damages in concrete infrastructure; (d) Equip students with knowledge on the assessment and prediction of the chronological deterioration of the structural performance of concrete structures; (e) Facilitate students with knowledge about the advanced repair and strengthening technologies for deteriorating concrete structures. (f) Facilitate students with knowledge about the life-end strategy of concrete infrastructure and construction waste management.
Intended Learning Outcomes	Upon completion of the subject, students will be able: a. to achieve an in-depth understanding of life-cycle performance management strategy of concrete infrastructure and the significance of implementing this strategy in pursuing the sustainability of concrete infrastructure; b. to grasp systematic knowledge on inspecting, diagnosing and monitoring the material and structural deterioration of concrete infrastructure; c. to correctly interpret the inspecting and diagnosing results and to conduct accurate assessment on the structural performance of deteriorating concrete structures and predict their future behaviour; d. to implement modern repair and strengthening technology for upgrading deteriorated concrete structures; e. to hold know-how on the recycling and management of construction wastes.
Subject Synopsis /	This subject covers the following contents:

<table>
<tr><td>Indicative Syllabus</td><td>1. <u>Framework for life-cycle performance management</u>
Infrastructure sustainability, fundamental principles of life cycle management, limit state design, life cycle-based design, life cycle cost analysis, state-of-the-art of the life cycle management technologies.

2. <u>Deterioration mechanisms of concrete materials and concrete structures</u>
Concrete spalling, efflorescence and leaching of concrete, steel corrosion, chemical attack, frost damage, alkali aggregate reaction, surface wearing, fatigue failure, seismic damage.

3. <u>Diagnosis, inspection and performance assessment</u>
Inspection and diagnosis, non-destructive/destructive testing, structural health monitoring, performance requirement, initial/detailed assessment, finite element modeling, expert system, residual service life prediction, probability-based approach.

4. <u>Repair and strengthening</u>
Repair of concrete cracks, surface coating, electro-chemical repair, structural strengthening methods, externally, bonded fiber reinforced polymer (FRP) technique including flexural strengthening, shear strengthening and seismic retrofit.

5. <u>Life-end strategies and environmental issues</u>
Concrete recycling, recycling of glass, carbon footprint evaluation

6. <u>Exemplary life cycle performance management tools</u>
Bridge management, building management, port structure management, pavement management, tunnel management.</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>The subject is delivered mainly using lectures which are focused on all relevant technical elements of the life cycle performance management of concrete structures. The lectures need to be supplemented by substantial self-study after class by students of reference materials and other up-to-date technical reports/journal papers recommended by the lecturer(s).

The students need to complete a set of assignments and an oral examination of the group reports at the semester end.</td></tr>
<tr><td>Assessment Methods in Alignment with Intended Learning</td><td>
<table>
<tr><td rowspan="2">Specific assessment methods/tasks</td><td rowspan="2">% weighting</td><td colspan="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td></td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td>Outcomes</td><td>
<table>
<tr><td>1. Assignments</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>2. Quiz</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>3. Project Report and Oral Examination</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>
Students must attain at least grade D in both coursework and final examination assessments (whenever applicable) in order to attain a passing grade in the overall result.

The students will be assessed with two components, i.e. 1. assignments, 2. an oral examination of the group report at the end of the semester. The students will be required to conduct extensive reading after the lecture to complete a set of assignments. Each assignment is designed to cover a particular technical aspect of the life cycle performance management system of concrete structures. Hence, they are considered to be highly effective in achieving the intended learning outcomes a), b), c), d), and e). Moreover, an oral examination is designed to assess the students' understanding on the basic concepts as well as the practice of the life cycle performance management on concrete infrastructure, and is effective to achieve all the intended learning outcomes.
</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures</td><td>39 Hrs.</td></tr>
<tr><td>▪ Examination</td><td></td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>26 Hrs.</td></tr>
<tr><td>▪ Assignments on small modeling problems</td><td>30 Hrs.</td></tr>
<tr><td>▪ Numerical modeling project</td><td>40 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>135 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>
• Books
(1) Hitoshi Furuta, Dan, M. Frangopol and Mitsuyoshi Akiyama, Life-Cycle of Structural Systems: Design, Assessment, Maintenance and Management, CRC Press, 2014, ISBN 9781138001206
(2) Gjøry, O., Durability Design of Concrete Structures in Severe Environments, CRC Press, ISBN 9781466587298, 2013.
(3) Teng, J.G., Chen, J.F., Smith, S.T. and Lam, L., FRP-Strengthened RC Structures, ISBN: 978-0-471-48706-7, Wiley, 2001.

• Codes of Practice
(1) fib Model Code for Concrete Structures, Ernst & Sohn, 2010, Lausanne, Switzerland
(2) ISO FDIS 16311-1, Maintenance and repair of concrete structures – Part 1: General principles.
(3) ISO FDIS 16311-2, Maintenance and repair of concrete structures –
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	Part 2: Assessment of existing concrete structures. (4) ISO FDIS 16311-3, Maintenance and repair of concrete structures – Part 3: Design of repairs and prevention. (5) ISO FDIS 16311-4, Maintenance and repair of concrete structures – Part 4: Execution of repairs and prevention. (6) Japan Society of Civil Engineer, Standard Specification for Concrete Structures-2001, “Maintenance”. • **Journals** (1) Structural and Infrastructure Engineering: Maintenance, Management, Life Cycle Design and Performance, Taloy & Francis.

Subject Description Form

Subject Code	CSE6014
Subject Title	Environmental Fluid Mechanics
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Recommended background knowledge: Students should have a knowledge and understanding of: undergraduate level of studies in engineering or science; and elements on coding using Matlab, Python, Fortran or equivalent programming languages.
Objectives	1. To provide students a better understanding of the mechanisms leading to various types of water/air dispersion behaviour. 2. To provide students a rational basis for devising water/air quality analysis strategies. 3. To provide students with the knowledge about the different numerical modelling & data analysis approaches. 4. To provide students with in-depth analysis ability of dispersion processes in different contexts.
Intended Learning Outcomes	Upon completion of the subject, students will be able: a. to formulate and develop mathematical models for water/air quality prediction. b. to devise suitable measures for water/air quality applications in different research fields. c. to apply knowledge in the analysis of data and incorporate the result into aqueous reactor for application; and d. to perform critical thinking on design/research methods and solutions.
Subject Synopsis / Indicative Syllabus	**Keyword Syllabus** 1. Mass transport processes. Modelling approaches and solutions (15 Hrs) Review of Diffusion and Dispersion Processes. The turbulent advection-diffusion equations and its applications for air/water quality. Dispersion of heavy/light particles in water and air: the role of buoyancy and inertia. Transport of reactive materials: models and solutions. 2. Numerical models for water and air quality and data analysis (12 Hrs) Elements of numerical methods: finite difference, finite volume and finite elements; meshless methods. Overview of modelling approaches: Eulerian and Lagrangian models. Data analysis: analysis of the velocity fields, Eulerian and Lagrangian measures of fluid mixing.

<table>
<tr><td></td><td>3. Applications: Water and air (12 Hrs)
Dispersion in natural water bodies and pressurized flows: Rivers mixing, mixing in Estuaries and coastal water induced by tidal, wind and wave currents.
Dispersion in air: applications to atmospheric pollution and indoor air quality, Gaussian models and Lagrangian models; transport of fine particles.</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>1. Lectures to deliver teaching materials. Lectures will provide fundamental methods and practical approaches to the students.
2. Students should explore journal papers on new methods, advanced techniques or basic theory related to the subject content and their study background & research field.
3. Tutorials will provide chances to the students to discuss their individual applications in detail with the lecturer in person. This is useful for best fitting the needs for the students with different backgrounds. The reports will relate to the subject contents and students' background.
4. The students will be asked to directly apply the methodologies of analysis presented during the lectures by preparing their own scripts and codes (Matlab, python, Fortran, or others proposed by the students).</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td></td><td></td></tr>
<tr><td>1. Assignments</td><td>50%</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>2. Project report</td><td>50%</td><td></td><td></td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>

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

Continuous assessment is based on

1) Assignments based on calculations of water/air mixing applications (50%).

2) Report on individual student project, based on numerical simulations performed using open source models and/or script developed by the students using Matlab, python or equivalent programming languages (50%).</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures and Tutorials</td><td>39 Hrs.</td></tr>
<tr><td>▪ Examination</td><td>--</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
</table>
</td></tr>
</table>

	▪ Reading of reference materials	36 Hrs.
	▪ Assignments	30 Hrs.
	▪ Project	30 Hrs.
	Total student study effort	135 Hrs.
Reading List and References	**<u>Books</u>** • Fischer, et al., Mixing in Inland and Coastal Waters, Academic Press, 1979. • Tennekes and Lumley, A First Course in Turbulence, The MIT Press, 1972. • Fernando, Harindra Joseph, ed. Handbook of environmental fluid dynamics, volume one: overview and fundamentals. CRC press, 2012. • Fernando, Harindra Joseph, ed. Handbook of Environmental Fluid Dynamics, Volume Two: Systems, Pollution, Modeling, and Measurements. CRC press, 2012. • Lynch, Daniel R., et al. Particles in the coastal ocean: Theory and applications. Cambridge University Press, 2015. **<u>Journals</u>** Journal of Geophysical Research Water Resources Research Environmental Science and Technology Journal of Fluid Mechanics Journal of Environmental Engineering, ASCE Atmospheric Environment Journal of Aerosol Science	

Subject Description Form

Subject Code	CSE6015
Subject Title	Transportation Optimization and Simulation Methods
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Students should have fundamental knowledge about mathematics and computation methods.
Objectives	This subject is intended to introduce a broad range of optimization and simulation methods for construction and transportation applications; and equip students with knowledge of applying the skills learned in this class to model and solve real- world problems in construction and transportation.
Intended Learning Outcomes	Upon completion of the subject, students will be able: a. to appreciate the need for a systematic approach for modeling different applications in construction and transportation; b. to equip students with a good understanding of the fundamentals in formulating and solving real-world problems in the field of construction and transportation; c. to demonstrate the capability to apply the skills learned in this course to model and solve real-world construction and transportation problems; d. to demonstrate the capability to write a technical report/paper and communicate the results of their solution approach to other engineering professionals
Subject Synopsis / Indicative Syllabus	This subject covers the following contents: 1. Fundamentals Basic principles in systems analysis applied to construction and transportation; Basic theory of optimization and simulation methods; Unconstrained and constrained optimization problems; Introduction to stochastic and multi-objective optimization problems 2. Network Flow Optimization Shortest path problems; vehicle routing problems; Traffic assignment problems (user equilibrium versus system optimal); Stochastic traffic assignment problems; Traffic assignment algorithms 3. Network Design Problems Traffic paradoxes (Braess paradox, stochastic paradox, capacity paradox, etc.); Game theory; Bi-level mathematical programs; Deterministic and stochastic network design problems; Iterative- optimization-assignment method; Sensitivity-based analysis method; Global optimization method; Metaheuristics 4. Complex System Problems Agent-based modeling; System dynamics; System of systems; Network theory

<table>
<tr><td></td><td>5. <u>Advanced Topics</u>
Supernetworks; Dynamic traffic assignment; Transit assignment; Reliability and vulnerability analysis</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>The subject is delivered mainly using lectures which are focused on optimization methods for formulating and solving real-world construction and transportation problems. The lectures need to be supplemented by substantial self-study after class by students of reference materials and other up-to-date technical reports/journal papers recommended by the lecturer(s).

The students need to complete a set of assignments and an individual project and presentation.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td></td><td></td></tr>
<tr><td>1. Assignments</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>2. Project Report and Presentation</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>

The students will be assessed with two components, i.e. 1. assignments, 2. Written individual project report and oral presentation at the end of the semester. The students will be required to conduct extensive reading after the lecture to complete a set of assignments. Each assignment is designed to cover a particular technical aspect of data analysis. Moreover, an individual project is designed to assess the students' understanding on the critical assessment and effective communication of the results of data analysis in solving real world problems. Hence, the students are considered to be highly effective in achieving the intended learning outcomes a, b, c and d.</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures</td><td>39 Hrs.</td></tr>
<tr><td>▪ Examination</td><td></td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>26 Hrs.</td></tr>
<tr><td>▪ Assignments</td><td>30 Hrs.</td></tr>
<tr><td>▪ Individual project</td><td>40 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>135 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>Books
(1) Anderson, D.R., Sweeney, D.J., Williams, T.A., Camm, J.D., Martin, K., 2012. An Introduction to Management Science: Quantitative Approaches to Decision Making. Revised 13th Edition, South-Western Cengage Learning, Mason, OH, USA.
(2) Ahuja, R.K., Magnanti, T.L., Orlin, J.B., 1993. Network Flows, Prentice Hall.
(3) ReVelle, C.S., Whitlatch, E.E., Wright, J.R., 2004. Civil and Environmental</td></tr>
</table>

Systems Engineering, 2nd Edition, Prentice Hall.

(4) Sheffi, Y., 1985. Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods, Prentice Hall.
(5) Bell, M.G.H., Iida, Y., 1997. Transportation Network Analysis, John Wiley & Sons, Inc.
(6) Nagurney, A., 1999. Network Economics: A Variational Inequality Approach, Kluwer Academic Publishing.
(7) Nagurney, A., Dong, J., 2002. Supernetworks Decision-Making for the Information Age, Edward Elgar Publishing Limited, Northampton, Massachusetts, USA.
(8) Wilensky, U., Rand, W., 2015. An Introduction to Agent-Based Modeling: Modeling Natural, Social, and Engineered Complex Systems with NetLogo, The MIT Press.

Journals

(1) Transportmetrica A: Transport Science, http://www.tandfonline.com/toc/ttra21/current
(2) Transportmetrica B: Transport Dynamics, http://www.tandfonline.com/loi/ttrb20
(3) Transportation Research Part B: Methodological, https://www.journals.elsevier.com/transportation-research-part-b- methodological
(4) Transportation Research Part C: Emerging Technologies, https://www.journals.elsevier.com/transportation-research-part-c- emerging-technologies/
(5) Transportation Research Part E: Logistics and Transportation Review, https://www.journals.elsevier.com/transportation-research-part-e- logistics-and-transportation-review/
(6) Travel Behaviourand Society, https://www.journals.elsevier.com/travel-behaviour-and-society/
(7) International Journal of Sustainable Transportation, http://www.tandfonline.com/loi/ujst20
(8) Journal of Computing in Civil Engineering, http://ascelibrary.org/journal/jccee5
(9) Environmental Modelling & Software, https://www.journals.elsevier.com/environmental-modelling-and- software
(10) Computer, Environment and Urban Systems, https://www.journals.elsevier.com/computers-environment-and- urban-systems/

Subject Description Form

Subject Code	CSE6721
Subject Title	Research Seminar 1
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure and horizon of the students in research and other related areas
Intended Learning Outcomes	To develop advanced and effective communication skills for both academic and non-academic communities
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two years. Students are recommended to complete one credit per year (for Full-time students) or per two years (for Part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for Full-time students) or per two years (for Part-time students) to fulfil the research seminar credit requirement. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. Students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. The Chief Supervisor has to pass the record of the seminars attended by their students and the report with a pass grade to Departmental General Office (for those admitted from the 2018/19 cohort onwards) or to Graduate School (for those admitted in or before the 2017/18 cohort) for custody at the end of each academic year.

Reading List and References	Nil

Subject Description Form

Subject Code	CSE6722
Subject Title	Research Seminar 2
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure and horizon of the students in research and other related areas
Intended Learning Outcomes	To develop advanced and effective communication skills for both academic and non-academic communities
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two years. Students are recommended to complete one credit per year (for Full-time students) or per two years (for Part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for Full-time students) or per two years (for Part-time students) to fulfil the research seminar credit requirement. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. Students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. The Chief Supervisor has to pass the record of the seminars attended by their students and the report with a pass grade to Departmental General Office (for those admitted from the 2018/19 cohort onwards) or to Graduate School (for those admitted in or before the 2017/18 cohort) for custody at the end of each academic year.

Reading List and References	Nil

Subject Description Form

Subject Code	CSE6723
Subject Title	Research Seminar 3
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure and horizon of the students in research and other related areas
Intended Learning Outcomes	To develop advanced and effective communication skills for both academic and non-academic communities
Subject Synopsis / Indicative Syllabus	Full-time/Part-time students are required to attend at least 10 research seminars per semester, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. Students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s). Each PhD student needs to give one research seminar, which should be comprehensible to a non-specialist. The seminar should last about 20 minutes, followed by Q&A for around 10 minutes.
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. The Chief Supervisor has to pass the record of the seminars attended by their students and the report with a pass grade to Departmental General Office (for those admitted from the 2018/19 cohort onwards) or to Graduate School (for those admitted in or before the 2017/18 cohort) for custody at the end ofthe semester. Departmental Research Committee should assign academic staff(s) to evaluate students' public seminars, with a pass/fail assessment.
Reading List and References	Nil

Subject Description Form

Subject Code	CSE6724
Subject Title	Research Seminar 4
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure and horizon of the students in research and other related areas
Intended Learning Outcomes	To develop advanced and effective communication skills for both academic and non-academic communities
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two years. Students are recommended to complete one credit per year (for Full-time students) or per two years (for Part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for Full-time students) or per two years (for Part-time students) to fulfil the research seminar credit requirement. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. Students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. The Chief Supervisor has to pass the record of the seminars attended by their students and the report with a pass grade to Departmental General Office (for those admitted from the 2018/19 cohort onwards) or to Graduate School (for those admitted in or before the 2017/18 cohort) for custody at the end of each academic year.

Reading List and References	Nil

Subject Description Form

Subject Code	CSE6710
Subject Title	Practicum 1
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure of students in teaching and academic related activities
Intended Learning Outcomes	To develop advanced and effective teaching and communication skills
Subject Synopsis / Indicative Syllabus	As part of the programme requirement, all PhD students, irrespective of funding source and mode of study, must complete two training credits before thesis submission. To earn one credit, students will be required to engage in teaching activities/professional service assigned by the HoD/DoS or his/her delegate for 6 hours/week in any 13-week semester. Students are allowed to complete these two credits any time before thesis submission. They can choose to complete these two credits in two different semesters or within the same semester, subject to the approval of the Chief Supervisor. Stipend recipients are **not** allowed to fulfill part of their departmental training requirement through the completion of these compulsory training credits. PhD students who will undertake teaching support activities must complete the following training programmes before the commencement of any teaching support activities: 1. Becoming an Effective Teaching Assistant (BETA) organised by the Educational Development Centre; AND 2. CEE in-house Teaching Assistant Training; AND 3. Training programmes organized by English Language Centre/Chinese Language Centre (if required).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to: a. ensure that the activities are structured and can be assessed properly; b. submit, at the end of the training session, an assessment report on the performance of the relevant student(s), with details of activities undertaken and an overall assessment grade of Pass or Fail.
Reading List and References	Nil

Subject Description Form

Subject Code	CSE6711
Subject Title	Practicum 2
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure of students in teaching and academic related activities
Intended Learning Outcomes	To develop advanced and effective teaching and communication skills
Subject Synopsis / Indicative Syllabus	As part of the programme requirement, all PhD students, irrespective of funding source and mode of study, must complete two training credits before thesis submission. To earn one credit, students will be required to engage in teaching activities/professional service assigned by the HoD/DoS or his/her delegate for 6 hours/week in any 13-week semester. Students are allowed to complete these two credits any time before thesis submission. They can choose to complete these two credits in two different semesters or within the same semester, subject to the approval of the Chief Supervisor. Stipend recipients are **not** allowed to fulfill part of their departmental training requirement through the completion of these compulsory training credits. PhD students who will undertake teaching support activities must complete the following training programmes before the commencement of any teaching support activities: 1. Becoming an Effective Teaching Assistant (BETA) organised by the Educational Development Centre; AND 2. CEE in-house Teaching Assistant Training; AND 3. Training programmes organized by English Language Centre/Chinese Language Centre (if required).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to: a. ensure that the activities are structured and can be assessed properly; b. submit, at the end of the training session, an assessment report on the performance of the relevant student(s), with details of activities undertaken and an overall assessment grade of Pass or Fail.
Reading List and References	Nil

Departmental Subjects

***L**and **S**urveying and **G**eo-**I**nformatics*

Subject Description Form

Subject Code	LSGI631
Subject Title	Attendance in Research Seminars/Workshops/Conferences I
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	To develop advanced and effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two years. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. RPg students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. Students are recommended to complete one credit per year (for full-time students) or per two years (for part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students) to fulfill the research seminar credit requirement.
Reading List and References	Nil

Subject Description Form

Subject Code	LSGI632
Subject Title	Attendance in Research Seminars/Workshops/Conferences II
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	To develop advanced and effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two years. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. RPg students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. Students are recommended to complete one credit per year (for full-time students) or per two years (for part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students) to fulfill the research seminar credit requirement.
Reading List and References	Nil

Subject Description Form

Subject Code	LSGI633
Subject Title	Attendance in Research Seminars/Workshops/Conferences III
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	To develop advanced and effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two years. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. RPg students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. Students are recommended to complete one credit per year (for full-time students) or per two years (for part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students) to fulfill the research seminar credit requirement.
Reading List and References	Nil

Subject Description Form

Subject Code	LSGI634
Subject Title	Attendance in Research Seminars/Workshops/Conferences IV
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure and horizon of the students in research and other related areas.
Intended Learning Outcomes	To develop advanced and effective communication skills for both academic and non-academic communities.
Subject Synopsis / Indicative Syllabus	Full-time students are required to attend at least 10 research seminars per year, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars every year. Part-time students are required to attend at least 10 research seminars per two years, in addition to workshops/conferences, and to submit a report, to the Chief Supervisor, of no less than 1,500 words (excluding references) on one of the attended seminars once every two years. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. RPg students should discuss with their Chief Supervisors the relevance and suitability of the seminars before attending the seminars. The scope of a seminar attended by an RPg student should have significant research value to his/her study, enabling him/her to keep abreast of the latest discovery and enhancing his/her knowledge in the field(s).
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to assess the report (with a pass or failure grade). Students who failed to submit a report to the satisfaction of their Chief Supervisor are required to make a re-submission until a pass grade is obtained. Students are recommended to complete one credit per year (for full-time students) or per two years (for part-time students) to fulfil the above-mentioned requirement, with an overall assessment grade of Pass and Fail. However, as deemed appropriate by the Chief Supervisor, they are allowed to complete at most two credits per year (for full-time students) or per two years (for part-time students) to fulfill the research seminar credit requirement.
Reading List and References	Nil

Subject Description Form

Subject Code	LSGI641
Subject Title	Practicum I
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure of the students in teaching and academic related activities.
Intended Learning Outcomes	To develop advanced and effective teaching and communication skills.
Subject Synopsis / Indicative Syllabus	As part of the programme requirement, all PhD students, irrespective of funding source and mode of study, must complete two training credits before thesis submission. To earn one credit, students will be required to engage in teaching/research supporting activities assigned by the HoD/DoS of his/her delegate for 6 hours/week in any 13-week semester. Students are allowed to complete these two credits any time before thesis submission. They can choose to complete these two credits in two different semesters or within the same semester, subject to the approval of the Chief Supervisor. PhD students who are recipients of stipend (who will be required to undertake departmental training of up to 6 hours per week) or TPS Assistantship (who will be required to undertake teaching assistant activities for 17 hours per week) are allowed to fulfil part of their departmental training requirement or their teaching assistant duties respectively through the completion of these compulsory training credits. *Note: The current departmental training requirements for all stipend recipients, MPhil or PhD, should remain unchanged.* <u>Teaching Experience</u> PhD students who are required to undertake teaching supporting activities in their training credits will be required to complete a training programme organized by the EDC as required by the Department/School. Students who are required to interact directly with students in

	English/Putonghua as a part of their duties in supporting teaching and learning must demonstrate their language competence to fulfil the intended duties to the satisfaction of the host department. All eligible students except those who are native English/Putonghua speakers will also be required to successfully complete a language training programme offered by the ELC/CLC before taking up any teaching supporting activities. *Note: The above-mentioned training requirements will also apply to MPhil students should they be required to undertake teaching supporting activities.*
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to: a) ensure that the activities are structured and can be assessed properly; b) submit to the Subject Assessment Panel, at the end of the training session, an assessment report on the performance of the relevant student(s), with details of activities undertaken and an overall grade of Pass or Fail.
Reading List and References	Nil

Subject Description Form

Subject Code	LSGI642
Subject Title	Practicum II
Credit Value	1
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	This subject is intended to enhance the exposure of the students in teaching and academic related activities.
Intended Learning Outcomes	To develop advanced and effective teaching and communication skills.
Subject Synopsis / Indicative Syllabus	As part of the programme requirement, all PhD students, irrespective of funding source and mode of study, must complete two training credits before thesis submission. To earn one credit, students will be required to engage in teaching/research supporting activities assigned by the HoD/DoS of his/her delegate for 6 hours/week in any 13-week semester. Students are allowed to complete these two credits any time before thesis submission. They can choose to complete these two credits in two different semesters or within the same semester, subject to the approval of the Chief Supervisor. PhD students who are recipients of stipend (who will be required to undertake departmental training of up to 6 hours per week) or TPS Assistantship (who will be required to undertake teaching assistant activities for 17 hours per week) are allowed to fulfil part of their departmental training requirement or their teaching assistant duties respectively through the completion of these compulsory training credits. *Note: The current departmental training requirements for all stipend recipients, MPhil or PhD, should remain unchanged.* <u>Teaching Experience</u> PhD students who are required to undertake teaching supporting activities in their training credits will be required to complete a training programme organized by the EDC as required by the Department/School. Students who are required to interact directly with students in

	English/Putonghua as a part of their duties in supporting teaching and learning must demonstrate their language competence to fulfil the intended duties to the satisfaction of the host department. All eligible students except those who are native English/Putonghua speakers will also be required to successfully complete a language training programme offered by the ELC/CLC before taking up any teaching supporting activities. *Note: The above-mentioned training requirements will also apply to MPhil students should they be required to undertake teaching supporting activities.*
Assessment Methods in Alignment with Intended Learning Outcomes	Chief Supervisors are required to: c) ensure that the activities are structured and can be assessed properly; d) submit to the Subject Assessment Panel, at the end of the training session, an assessment report on the performance of the relevant student(s), with details of activities undertaken and an overall grade of Pass or Fail.
Reading List and References	Nil

Subject Description Form

Subject Code	LSGI651
Subject Title	Advanced GNSS Technology and Applications
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	(1) Understand the principle, theory and advanced technology of GNSS precise positioning technology (2) Discuss the scientific and engineering applications of GNSS technology (3) Explore the novel applications of GNSS in the students' research areas
Intended Learning Outcomes	a. understand the principle, theory and advanced technology of the modern satellite-based GNSS positioning and navigation technology; b. hands-on experience of the advanced GNSS applications in environment monitoring and/or other construction areas; c. understand the state-of-the-art of research in GNSS; and d. apply what is taught in this class to their research topics.
Subject Synopsis / Indicative Syllabus	• Introduction to GNSS systems ▪ Space segment ▪ Control segment ▪ User segment ▪ Development and status of multiple global and regional GNSS systems • Principle of GNSS positioning ▪ The coordinate system ▪ The time system ▪ GNSS orbits ▪ GNSS signals • GNSS observation and data structure ▪ Carrier phase observation ▪ Pseudorange observation ▪ Observation combinations ▪ Pseudorange smoothing ▪ Carrier phase ambiguity resolution • GNSS error sources and modeling ▪ Ionospheric error and its modeling ▪ Tropospheric error and its modeling ▪ Multipath error and its modeling ▪ Clock error and its modeling

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Biases and its modeling

GNSS positioning and augmentation methods

Differential GNSS (DGNSS)
Real-time-kinematic GNSS and network RTK
Precise Point Positioning (PPP)
Space-based augmentation system (SBAS)
Ground-based augmentation system (GBAS)

Advanced Applications of GNSS

Application in ground traffic ITS
Application in aviation traffic SBAS
Application in geohazard monitoring
Application in structure health monitoring
Application in water vapor remote sensing
Application in space weather monitoring

</td></tr>
<tr><td>Teaching / Learning Methodology</td><td>This subject will be taught and learnt through an instructor-student, theory-practice interactive method. The question-oriented teaching method will be used in the classroom to engage with the PhD students. The students will be asked to conduct two problem-oriented projects in this subject, the outcome of which will be shared to the whole class through oral presentation. This will help the PhD students to enhance their project implementation, project management and project presentation skills.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td></td><td></td></tr>
<tr><td>1. In-class test</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Project report</td><td>50%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
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</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>27 Hrs.</td></tr>
<tr><td>▪ Lab/Tutorial</td><td>12 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>35 Hrs.</td></tr>
<tr><td>▪ Writing project report</td><td>35 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>109 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>References:

Elliott Kaplan and Christopher J. Hegarty (2017), Understanding GPS/GNSS: Principles and Applications, Third Edition (GNSS Technology and Applications Series), 3rd Edition, Publisher: Artech House.
Ben Levitan and Lawrence Harte (2016), GPS Systems: Technology, Operation, and Applications, Publisher: Discovernet.
Leick Alfred (2015), GPS Satellite Surveying (3rd Edition), Publisher: Wiley (India).

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Subject Description Form

Subject Code	LSGI652
Subject Title	Remote Sensing in Construction, Urban and Environment
Credit Value	3
Level	6
Pre-requisite / Co-requisite / Exclusion	Nil
Objectives	• To provide an understanding of advanced remote sensing technologies, such as Ground Penetration Radar (GPR), Radar Interferometry (InSAR), Laser Scanning technology (LiDAR) and hyperspectral remote sensing; • To enable students to deeply understand the state-of-the-art research in these relevant areas; • To enable students to properly identify feasible research topics in these areas.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. Master research theory, technology of advanced remote sensing technology; b. Understand the applications in Construction, Urban and Environment; c. Articulate the technologies relating to the integration of disparate sources of acquisition covered in this topic; d. Appreciate the effectiveness and limitation of using these technologies in real-world applications.
Subject Synopsis / Indicative Syllabus	• Ground Penetration Radar (GPR) technology and application in Construction, Urban and Environment • LiDAR technology and applications in Construction, Urban and Environment • InSAR technology and applications in Construction, Urban and Environment • Multi-spectral remote sensing and applications in Construction, Urban and Environment • Hyperspectral remote sensing and applications in Construction, Urban and Environment • UAV technology and applications in Construction, Urban and Environment • Future developments/trends in remote sensing technology.
Teaching / Learning Methodology	This subject will be taught and leant through an instructor-student, theory-practice interactive method. The question-oriented teaching method will be used in the classroom to engage with the PhD students. The students will be asked to conduct two problem-oriented projects in this subject, the

<table>
<tr><td></td><td>outcome of which will be shared to the whole class through oral presentation. This will help the PhD students to enhance their project implementation, project management and project presentation skills.</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="6">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td></td><td></td></tr>
<tr><td>1. In-class test</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Project report</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>3. Assignment</td><td>40%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
</table>
</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lecture</td><td>26 Hrs.</td></tr>
<tr><td>▪ Lab/Tutorial</td><td>13 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>39 Hrs.</td></tr>
<tr><td>▪ Writing project report</td><td>39 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>117 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>References:

Hanssen, R.F. (2001), Radar Interferometry Data Interpretation and Error Analysis, 328 pp., Springer, New York.
Ferretti A., Monti-Guarnieri A., Prati C. (2007), InSAR Principles: Guidelines for SAR Interferometry Processing and Interpretation, ESA Publications. Noordwijk 234 p
Anderson, A., Hardy, E., Roach, J., Witmer, R.. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper No. 964, US Government Printing Office.
Nichol, J.E., Fung, W.Y., Lam K.S., and Wong, M.S., (2009). Urban Heat Island diagnosis using ASTER satellite images and ‘in situ’ air temperature. Atmospheric Research, 94, 276-284
Strahler, A.H. 1986. On the nature of models in remote sensing, Remote sensing of Environment 20, 121-139.
Lillesand, T. and Keifer 2008, Remote Sensing and Image Interpretation, 6th ed. Wiley.
Nichol, J.E, 2009. Remote sensing of urban areas. Chapter 32, In Handbook of Remote Sensing, D. Warner, D. Nellis, and G. Foddy (eds), Sage Publications.

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</table>

Part IV
Appendices

Appendix A: Research Committees

PolyU Currently has 3 tiers of administration for matters related to research, namely the Graduate School Board, the Faculty Research Committee and the Departmental Research Committee, to govern and discharge duties in relation to research postgraduate studies.

A1. Graduate School Board (GSB)

The Hong Kong Polytechnic University Graduate School Board (GSB), a Committee of the Senate, is responsible for, amongst other things, reviewing and formulating major RPg education policies, regulations and procedures; monitoring the progress, examination and graduation of RPg students; endorse new initiatives in relation to RPg education; allocating budgets to various funding schemes related to RPg students; and allocating research studentships to Faculties and Departments.

A2. Faculty Research Committee (FRC)

At Faculty level, the FRC plays an important role in reviewing and developing policies and regulations regarding research and research postgraduate studies and makes recommendations accordingly to the Research Committee and Graduate School Board. The FRC provides a forum for discussion and debate on issues of significance relating to research and research postgraduate studies, fostering a culture of active research in the Faculty and encouraging further development in line with the University's research policies.

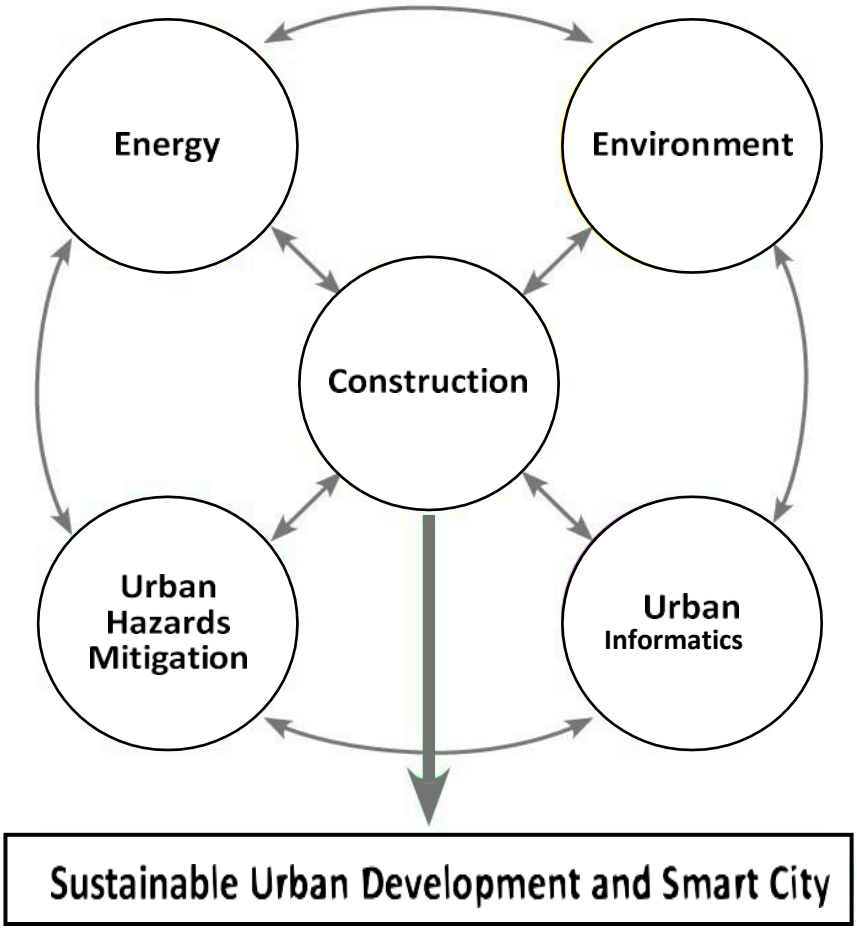
A3. Departmental Research Committee (DRC)

Each department has a research committee. The DRC carries out functions as stipulated in the Administrative Procedures for the research degrees offered by The Hong Kong Polytechnic University for research postgraduate students, including but not limited to considering research postgraduate degree candidates, and monitoring the progress of research projects and of research postgraduate students in the Department.

Appendix B: FCE Research Theme and Departmental Focused Research Areas

B1. Faculty Research Direction

With the largest concentration of research expertise in the construction and environment fields in Hong Kong, FCE is at the forefront of multi-disciplinary and cutting-edge research on Sustainable Urban Development. The interdisciplinary research areas of our four departments focus on various aspects of Sustainable Urban Development, which impinge on and are informed by the fields of Construction, Energy, Environment, Urban Hazards Mitigation and Urban Informatics, as illustrated in the chart below. By consolidating and enhancing our strengths in the interlocking areas, the Faculty is well positioned to become a world leader in creating innovative solutions for Sustainable Urban Development and Smart City.



B2. Focused Research Areas of the Departments

Department of Building Environment and Energy Engineering (BEEE)
https://www.polyu.edu.hk/beee/

Building Energy Efficiency

Energy issues in the building and built environments will be addressed in the context of both demand and supply. Enhancing energy efficiency on the demand side by optimized design and smart control of energy systems, and the effective use of renewables on the supply side as well as the innovative use of waste for clean energy generation. Research topics include: robust and optimal design of building HVAC systems; optimal control of building HVAC systems; energy assessment/diagnosis of buildings with deficient high volume information (Big Data); demand management for smart grid; photovoltaic integration; hybrid solar-wind power generation; development of advanced renewable energy technologies; hybrid ground-coupled heat pump applications for air-conditioning in hot-climate region; highly dispersed nanocomposite for self-cleaning photovoltaic panels; green building nanomaterial and novel building envelope technology development; novel solar heat-reflective insulation material based on hollow glass micro-balloon cores with hierarchical porous rutile TiO2 coating; sustainable energy conversion and storage with emphasis on high temperature fuel cells for efficient energy conversion from biofuels or organic waste; planting techniques for enhancing CO2 absorption for urban rain gardens; technology development and economic feasibility of applying new urban bio-refinery to convert solids wastes derived lignocellulosic biomass into biofuels; low-carbon construction processes.

Building Environment

Research in this area has helped improve indoor and outdoor environments, such as HVAC systems to control indoor air temperature and humidity for thermal comfort and energy efficiency. Improving indoor built environments involves thermal, indoor air quality (IAQ), visual and acoustic aspects. Technology enabling ventilation and sound insulation has been applied in hostels, public housing estates and a private housing estate. For the best possible indoor environment at the least energy consumption, research needs to focus on developing innovative technologies and improving and integrating existing technologies. These include: precise control of indoor thermal parameters; novel ventilation strategy for improved IAQ at the lowest possible energy use; ventilation-enabling sound insulation technologies; novel indoor silencing devices; the use of daylight for energy saving and visual comfort etc. A fundamental understanding of human responses to light stimuli, including visual, non-visual, and behavioral responses, from psychophysical, physiological, and psychological perspectives, is also required. Enhanced wind and thermal comfort in the urban environment can be developed through computational modeling, new design tools and policy reviews. Multi-disciplinary sound quality assessment and improvement strategies for sustainable city design is another focus. This includes the improvement of total thermal, visual, air and sound quality of the neighborhood environment.

Building Safety and Resilience

With intelligent facilities in tall buildings, traditional aspects of building safety such as structural strength and fire resistance must also include newer concerns, such as interference of lightning bolts with electrical and electronic systems. In collaboration with the Shenzhen Meteorological Bureau, a 362 m-high tower was installed with sensors and measuring systems to provide a unique experimental platform for researching the atmospheric environment, such as enabling the interaction of lightning with modern facilities to be investigated in real scale. As the actual lightning current is captured for testing, practical and effective techniques for protection of buildings against lightning can be developed. The mechanisms and process of fire ignition due to lightning current could also be investigated. To develop fire safety provisions for supertall buildings, fundamental studies on smoke movement can be conducted. An earlier study of wind effects on fires in a supertall building has demonstrated that heat and smoke emitted from a fire in a supertall building would spread upward, with air entrained at lower levels. The structural response to fire could be simulated to facilitate an understanding of the progressive collapse mechanisms of tall buildings in large fires that may spread over multiple floors.

Department of Building and Real Estate (BRE)
http://www.bre.polyu.edu.hk/

Construction Health and Safety

This research area aims to create a safe, healthy, and productive environment (eSHAPE) for construction workers by developing anti-heat stress measures, detecting and mitigating noise hazards, profiling workers' health, developing health and safety measures for workers exposed to silica dust in construction, and reducing the health risks of workers due to hazardous chemicals emission.

A construction uniform with better ultraviolet protection, better breathability and a faster evaporation rate of sweat has been developed for workers who have to toil in hot and humid conditions. Since its launch, the uniform has been adopted by the construction industry. Assessing the level of environmental and physical hazard exposures in the construction industry, and investigating the impacts of different types of chemical and physical hazards on the occupational health of construction workers will better guide occupational health and safety (OHS) policy and measures, applying controls when and where appropriate, as well as informing construction workers about adverse health behaviors.

Digital Construction

This research area aims to develop digital solutions to ensure successful project delivery of construction projects with minimum time and cost, while maintaining high quality and reducing accidents. The emergence of digital technologies has the potential to greatly improve the project delivery processes. For example, Building Information Modelling (BIM) enables 3D representations of building components and processes. The Internet of Things (IoTs) facilitates information exchange between machines without the need for human intervention. Industrial robotics and 3D printing technologies can automate construction operations.

Sustainable Urban Systems

This research area aims to achieve sustainable urban development by conducting scientific studies at a whole range of levels, from industrial to city to districts etc. A 3D spatial analysis of different plot ratio/building height (PR/BH) scenarios on urban skyline, visual effect, shadow and insolation, wind ventilation, and air temperature has enabled decision makers to formulate scientific and rational decisions for sustainable urban development. At the building level, an energy assessment system for new buildings and a unified decision support system for green retrofit in existing buildings have been developed. At the project level, a RFID-Enabled BIM Platform for Prefabricated Housing Production in Hong Kong has facilitated effective management of the supply chain in prefabricated housing production. This platform has been widely regarded as a very useful tool for information management by stakeholders in the supply chain, including the Housing Authority (the client), Gammon Construction (the contractor), and Wing Hong Shun (the façade supplier). Research in this area is primed to inform the construction of smart cities, which is the foreseeable trend of the future.

Department of Civil and Environmental Engineering (CEE)

https://www.polyu.edu.hk/cee/

Smart and Resilient Transportation

Traffic congestion, air pollution, and inclement weather are ongoing problems in many densely populated cities in Asia such as Hong Kong. Their impacts on economic productivity, network resilience, the environment, human health and safety are undeniable. However, due to the topography and the constraints of urban development in Hong Kong, further expansion of the existing road transport network is open to question. ***Smart and resilient transportation*** addresses the multi-modal transportation needs of society in a sustainable manner. The development of Intelligent Transportation Systems (ITS) is one of the essential steps towards ***smart and resilient transportation*** in Hong Kong's congested transportation network under uncertainties.

This research area includes developing various advanced solution algorithms for data fusion of different real-time traffic sensor data, robust solution algorithms for on-line estimation of journey times, traffic speeds and traffic states in congested networks with uncertainties, reliability-based path finding algorithm for ITS applications, and computational methods for enhancing network resiliency. The results have contributed to the advancement of the relevant research fields, and at the same time have made significant impacts in Asian cities. Some of the robust solution algorithms developed have already been implemented in the ITS projects in Hong Kong and Bangkok. It is hoped that further research would improve the efficiency and resiliency of traffic systems together with the planning, design and operation of urban infrastructure.

Sustainable Urban Environment

Deteriorating air quality, increasing amounts of wastewater and solid waste, and rapidly growing energy consumption have been major environmental problems in densely populated cities such as Hong Kong. These issues pose threats to human health and the ecosystem, and impede the potential for urban development. Owing to their extreme complexity and rising mitigation/treatment costs, the solutions to these issues remain elusive. The research area on ***Sustainable Urban Environment*** explores cost-effective pathways of development in theory and in practice for combating these environmental problems in urban cities.

The research area includes studies on the formation mechanism and abatement strategy of atmospheric pollution, the chemical and biological treatment of wastewater, the generation of energy by harnessing wastewater, wood and food waste, and the conversion of different types of waste to construction materials (e.g. Eco-block). The research findings have contributed to the formulation and evaluation of pollution control policies both locally and internationally (*e.g.*, assessment of vehicular emission control and cross-border impact on air quality in Hong Kong and of air pollution mitigation measures during the Beijing Olympics); the Eco-block technology has been transferred to the private sector and it has been widely used in Hong Kong.

Sustainable Materials and Structures

The sustainability of urban infrastructure is an issue of great concern to all major cities and particularly high-density cities such as Hong Kong. Research in the area of **Sustainable Materials and Structures** aims to enhance the sustainability of urban infrastructure by minimizing the use of materials and resources (and hence the carbon footprint) per year of service for a given infrastructure project. Researchers from structures, pavements and concrete technology in CEE work synergistically with researchers outside CEE (e.g., researchers in material science, chemistry and computer science) to enable major advances in the area.

The infrastructural use of high-strength materials such as fiber-reinforced polymer (FRP) composites, high-strength steel and ultra-high performance concrete for a new generation of infrastructure has enabled huge savings in construction materials. Research on long-life infrastructure by means of high-durability materials and/or advanced monitoring and retrofitting techniques is another related aspect. In ensuring the long-service life of infrastructure, smart technologies are needed to equip our infrastructure with the ability to sense, respond to and recover from severe environments (e.g., marine environments) and extreme loadings (e.g., typhoons and earthquakes).

Despite the use of high-performance materials and advanced technologies to extend the life- span of infrastructure, any structure/facility will still have a finite life. Therefore, end-of-life strategies for demolition wastes are crucial for the sustainability of infrastructure. How to recycle demolition and other wastes into new structures and useful products is also part of this research area.

Urban Geohazards and Mitigation

There are over 60,000 registered cut-slopes in Hong Kong, but there are numerous slopes in natural terrain in Hong Kong. Our research efforts are divided into hazard analyses of cut-slopes and their remediation, and hazard analysis and remediation of natural terrain in terms of debris flows. Fatal cut-slope failures have been rapidly reducing in recent years. Thus, the focus has been shifted to the study and monitoring of slopes in natural terrains.

Our efforts on geohazards and mitigation relating to landslides can be classified into two main domains: (1) theoretical, experimental and numerical analyses on landslides, rockfalls and debris flows hazards; (2) Field monitoring technologies for slope monitoring. First, numerical, theoretical, experimental analyses and field studies on debris flow, slope failures, rockfall and various innovative slope stabilization methods/materials were conducted at PolyU. Secondly, GIS, GPS, IOT, fibre optic sensors and cloud computing have been employed for slope monitoring in the last few years. Commercial software “Slope 2000” and “Slope3D” were developed and approved by the Buildings Department, and have been used in many large scale/national projects all over the world. A Collaborative Research Fund was granted by RGC for building a large scale debris flow flume.

Department of Land Surveying and Geo-Informatics (LSGI)
http://www.lsgi.polyu.edu.hk

Smart Positioning and Mobility

Navigation technologies are the core technologies to support a mobile internet, Location Based Services (LBS), and the Internet of things (IoT). Satellite based navigation systems (i.e. GPS, GLONASS, Beidou, and Galileo), as the backbone of navigation technologies, have become the fundamental infrastructure for national security and economic growth. Smart mobility is crucial for a smart city by reducing traffic congestion and pollutions, improving transfer speed and safety, and reducing transfer cost. LSGI has conducted research on navigation technologies and smart mobility for more than 30 years. A Navigation Laboratory has been established since 1999. In recent years, research on key issues (i.e. GNSS signal shadowing, GNSS multipath, and seamless positioning) for urban positioning and navigation technologies has supported economic development in Hong Kong. As a satellite navigation system developed in China, Beidou has been integrated with other navigation systems to improve navigation performance in urban areas and to promote the applications of the Beidou system internationally. A public transport enquiry system has also been developed and adopted by the Transport Department for public use since 2010.

Spatial Big Data Modelling and Analytics

Spatial big data modelling and analytics is based on a) the emerging research topic of big data, especially spatial big data in the geographic information science (GIS) community, and b) the related research accumulation of LSGI in the areas of spatial, temporal and dynamic data modelling, and spatial analyses in GIS. The proposed focus will contribute to the research and development of urban informatics in smart city with respect to data modelling and analysis. Strategies for this research focus include (i) identifying the need for spatial big data modelling and analytics in the context of smart city development; (ii) forming an inter-disciplinary research team at PolyU on spatial big data analytics; (iii) applying for large research grants related to this research focus; (iv) developing solutions for spatial big data modelling for heterogeneous, multi- resolution sources of spatial data; (v) creating spatial data models for an integrated indoor and outdoor environment; (vi) proposing analytical methods for dynamic urban data; (vii) analyzing and predicting urban mobility and dynamic behavior based on spatial bigdata.

Urban Sensing and Measurement

Research in this area has included urban heat island research, urban atmosphere monitoring, urban hazard monitoring, urban utility and infrastructure monitoring and management, urban 3D mapping, and 3D modelling for urban applications. The research prospect for the future will include (i) urban remote sensing for environment monitoring and modelling; (ii) urban remote sensing for hazard/deformation monitoring of urban infrastructures; (ii) urban underground utility monitoring and management; (iii) advanced photogrammetric hardware and software systems for near real-time 3D measurement of urban scenes; (iv) more automated 3D/4D city modelling with a high level of details from multiple-source remote sensing datasets; (v) developing a spatial data infrastructure for smart city development in Hong Kong.

Appendix C: Faculty and University Central Research Facilities

C1. Faculty Research Facilities

The Faculty and its Departments provide tremendous funding for research infrastructure development and enhancement. Please visit the websites of our four departments for details of the state-of-the-art equipment and facilities of our 60 research laboratories.

Department of Building Environment and Energy Engineering (BEEE)

BEEE	**Acoustics Laboratory** This lab is equipped with all essential and advanced equipment for the study and measurement of sound and vibration (both indoor and outdoor). There is an acoustics testing chamber that conforms to ISO/BS/ASTM standards for testing sound transmission loss, sound absorption and machine sound power. **Advanced Air-conditioning and Energy Storage Technology Laboratory** This laboratory consists of two experimental test rigs for carrying out both scientific and applied research on the advanced liquid desiccant dehumidification system and the novel three-phase absorption thermal energy storage system. The two test rigs are equipped with advanced data acquisition system, which can measure and collect a large number of physical and chemical properties for characterizing and modeling of the two types of system. The test rigs can also facilitate the development and test of the control methods/strategies. **Advanced Cooling System Laboratory** The laboratory aims to provide a platform for students to conduct scientific research, experiments and measurement on advanced cooling technologies. The facilities can be used to evaluate surface energy and thermal behaviour of advanced building envelopes and to investigate advanced solar PV glazing technologies. **Building Energy and Automation Research Laboratory** The Building Energy and Automation Research Laboratory facilitates research on building energy efficiency and the use of modernIT/computing technologies to improve building energy performance. It has developed a building system online performance simulationplatform and a building automation control and diagnosis strategy online test platform, in addition to various tools for building performancediagnosis and optimisation. Developing and managing a centralised energy monitoring and assessment platform to monitor and control theenergy performance of PolyU's campus buildings, the lab also helps many local developers and building owners to develop optimal andenergy-efficient control strategies and optimised control instrumentation solutions to improve the energy efficiency of their buildings. **Built Environment Simulation Laboratory** The Built Environment Simulation Laboratory is a research facility equipped with the state-of the-art multimedia hardware and software for carrying out environmental simulations and

	experiments using immersive virtual reality. Students can make use of the Lab to explore different disciplines in the digital media and integrate creative technologies into their research projects. **Colour and Illumination Laboratory** Facilities in the lab cover a wide range of testing, measurement, and calibration equipment and protocols for various imaging systems, including cameras, displays, virtual reality, augmented reality, and mixed reality systems. In addition, various tunable lighting equipment can be used to carry out experiments to better understand how the human beings respond to light and color stimuli under different viewing conditions. These can be used to develop metrics for different imaging systems and also to further our understanding about the human visual system. **Design and Development Centres** Computer-Aided Design (CAD) and drafting forms an important part of the Department's teaching programmes. The facilities in the Design and Development Centres include the latest Pentium computers and various plotting and printing facilities linked by a LAN. Peripherals include scanners, digitisers, large plotters and various printing facilities. It also provides computing facilities for students. **Electrical Services Laboratory** Facilities in the electrical services lab are suitable for testing and commissioning electrical installations, testing electrical equipment, conducting power quality analyses (harmonics, transients, etc.) and electro-magnetic field measurements and lightning detecting and monitoring systems, among others. **Fire Engineering Laboratory** There are two fire chambers that are well-equipped with instruments such as thermocouples, velocity sensors, oxygen analysers and gas analysers for conducting measurements in full-scale burning tests. Fire protection systems are installed for studying system performance. Wind tunnels are available for evaluating the thermal sensitivities of sprinkler heads and fire detectors. **HVACR Laboratory** Air conditioning systems provide comfortable interior thermal environments for building occupants. The process involves the removal of heatand humidity by different types of air handling equipment. Fans are used to distribute the conditioned air to various interior zones of abuilding through air ducts. In the HVAC lab, students can study the operating characteristics of fans and the air-flow disturbance along an airduct using the Fan Test Rig and the Air Duct and Damper Test Rig. Other experimental equipment includes a Refrigeration Laboratory Unit, aBench Top Cooling Tower and an Air Conditioning Laboratory Unit.

BEEE	**Indoor Environmental Quality Laboratory** Most of the test rigs in this lab are portable, comprising various gas analysers, temperature, humidity and air flow sensors for measurements inoccupied spaces, on air-side systems, etc. The manikin is an important piece of equipment for investigating thermal comfort and indoor airquality. Integrated analysis of the data in different areas such as thermal comfort, indoor air quality and subjective human responses can becarried out. **Indoor Air Quality (Bioaerosal) Laboratory** The Laboratory at Biological Safety Level 2 (BSL-2) is equipped with a Class II biological safety cabinet, as stated in the "Guidelines on Biosafety in the Clinical Laboratory" issued by the Department of Health (2005). The lab is also equipped with a wide range of bioaerosol sampling facilities for laboratory and field studies, including single stage impactors, Anderson samplers, biotest RCS plus, an incubator and an autoclave. **Intelligent Building Laboratory** The Intelligent Building (IB) Laboratory facilities include a comprehensive IB system, a full set of building automation systems, test rigs for IoT-enabled building automation, VR and AI-enable building energy facility management, grid-interactive building technology and energy-flexible building technologies as well as a variety of measurement instruments for building energy monitoring. The IB lab provides test facilities for teaching and learning as well as for R&D on intelligent building technologies, the development of advanced building system control, energy management, diagnosis strategies and communication software. **Lighting Laboratory** The Lighting Lab's goniophotometer, integrating sphere and spectroradiometer help to characterise various photometric (e.g., luminous flux, luminous intensity distribution) and colorimetric (e.g., spectral power distribution, correlated colour temperature, chromaticity coordinates, CIE Colour Rendering Index, IES TM-30-15, etc.) quantities for light sources and luminaires. The High Dynamic Range Imaging System allows us to perform luminance and glare analyses for exterior and interior luminous environmental assessments. In addition, the 14-channel spectrally tunable LED lighting system, spectroradiometer, spectrophotometer and standard viewing booth allow us to simulate different lighting conditions and to perform colour characterisation using different materials and surface colours. **Lightning Physics and Protection Laboratory** This lab facilitates research on the formation, detection of and protection from lightning. It includes various instruments specially designed for lightning research, such as slow and fast antennae and a magnetic loop antenna for measuring lightning- caused electric fields, a lightning location system, high-speed camera, broadband interferometer system and lightning current measuring system. It also includes various instruments for general use, such as high-speed oscilloscopes and data recorders. Due to the nature of lightning, these instruments are usually installed in fields outside the lab for experiments during the summer. The lab also has various sets of software for modelling lightning processes.

BEEE	**Low-carbon Building Technology Laboratory** The Low-carbon Building Technology Laboratory consists of a stainless-steel cladded environmental chamber the size of a typical office, and a stand-alone air-conditioning system equipped with three thermal manikins and temperature, aerosol and VOC sensors. The lab accommodates a variety of experimental studies. **Multi-Function Chamber Laboratory** The Multi-Function Chamber Laboratory is equipped with a main heating and cooling plant comprising a chiller, a boiler, hot and chilled water pumps, an air handling plant and a main supervisory control and data acquisition centre. The temperature, relative humidity and airflow within the chamber can be precisely controlled over a wide range of set-point conditions for various precision measurements. **Piped Services Laboratory** This lab provides facilities for testing and commissioning water supply and drainage systems for buildings. Bench-scale test rigs are set up to assess the performance and efficiency of various system components. **Renewable Energy Laboratory** Established in August 2014, the lab enables fundamental and applied research on solar energy materials and green building materials in collaboration with industry and leading academic institutions, providing advanced and innovative technological solutions for the generation of renewable energy and a sustainable built environment. **Solar Simulation Laboratory** The lab provides facilities for testing solar energy devices for thermal and photovoltaic applications. The solar simulator is mainly used for the research and development of solar energy applications in buildings, product tests of solar energy equipment and heat loss measurements of various building façade elements and devices. **Spectral-tunable Lighting Laboratory** Spectral-tunable Lighting Laboratory has various lighting devices that allow flexible adjustments of the spectral power distribution of light stimuli and also measurement devices. The facilities are used to investigate human perception to light stimuli, and also to develop algorithms and systems (e.g., cameras and displays) to capture and reproduce scenes.

Department of Building and Real Estate (BRE)

BRE	**Smart Construction Laboratory** The Smart Construction Laboratory has been providing industrial services covering and extending the use of Building Information Modelling (BIM), process simulation solutions and professional training to the construction industry. **Ng Wing Hong Laboratory for Sustainable City** This high-level laboratory provides an information technology infrastructure for examining the sustainable development of Hong Kong at the building and city level. The laboratory facilitates the archiving, processing and retrieval of databases and information in multi-media formats. **Energy Laboratory** The laboratory provides facilities to support cutting-edge scientific research on advanced energy systems, such as high temperature fuel cells for energy conversion, metal air batteries for energy storage and electrochemical systems for low-grade heat harvesting. **Building Technology Laboratory** The laboratory provides demonstration classes and hands-on building technology experiments on structural mechanics, concrete testing and non-destructive techniques for building diagnostics and inspection. The Laboratory supports research on 3D concrete printing, construction robotics and robotics exoskeleton. **IT Teaching Room** Students can use any of the PC stations in the IT Teaching Room on a first-come, first-served basis during non-teaching sessions. **Smart Infrastructure Management Systems Laboratory (SIMS)** The mission of SIMS is to foster world class excellence in research, training and technology transfer activities in the important area of sustainable civil infrastructure. The emphasis is on the research and development of effective design, rehabilitation, and management strategies.

Department of Civil and Environmental Engineering (CEE)

CEE	The Department manages 29 laboratories and 2 workshops (mechanical and electronic) to provide a controlled environment to support teaching, research and services to the community. The Department has the following laboratories and workshops under different units. **Construction and Transportation Unit** - Road Research Laboratory - Transport and Highway Engineering Laboratory **Environmental Engineering Unit** - Advanced Environmental Microbiology Laboratory - Air Pollution Laboratory - Atmospheric Research Laboratory - Bioenergy Research Laboratory - Carbon Analysis and Filter Handling Clean Room - Environmental Chamber - Laboratory for Advanced Environmental Studies - Noise and Safety Laboratory/ Semi-anechoic Chamber - Odour Research Laboratory - Water and Waste Teaching Laboratory - Water and Waste Research Laboratory - Water Analysis Laboratory **Geotechnical Engineering Unit** - Geology Laboratory - Rock Mechanics Laboratory - Smart Geotechnology Laboratory - Soil Mechanics Laboratory **Hydraulic Engineering Unit** - Hydraulics Laboratory **Structural Engineering Unit** - Concrete Materials Laboratory - Concrete Technology Laboratory - Engineering Materials Micro-Mechanics Laboratory - Functional Construction Materials Laboratory - Light Structures Laboratory - Materials and Structures Durability Laboratory - Structural Engineering Research Laboratory - Structural Dynamics Laboratory - Smart Structures Laboratory **Workshops** - Electronic Workshop - Mechanical Workshop **Others** Computer Room

Department of Land Surveying and Geo-Informatics (LSGI)

LSGI	**Laboratory for Smart City and Spatial Data Analytics** The Laboratory aims to bring academics, researchers, professionals and students together to generate innovative ideas, advanced technologies and practical solutions for smart cities. It provides one-stop facilities for research and development, including a spatial big data analytics server, spatial 3D data server, video- conferencing, TV wall, virtual reality (VR) and augmented reality (AR) visualisation systems. **Survey Store and Instrumentation Laboratory** The lab loans equipment and maintains and produces special accessories to support teaching and research activities in the Department. **Digital Cartography Laboratory** This lab is equipped with 40 sets of computers and digitising tablets. Installed with various GIS, CAD and database software, the laboratory is used mostly for teaching and students' practical work in GIS, cartography and digital mapping. **Underground Utility Survey Laboratory** This lab provides an indoor and controllable environment in which the orientations, depths, sizes, material types and coordinates of various utility networks are carefully designed and recorded. All of these attributes are geo-referenced and integrated into a geographic information system. Surveys are conducted by a range of utility survey and near-surface geophysical equipment. **Geomatics Computing Laboratory** This lab provides a general computing facility for all teaching staff and students in the Department to achieve a number of teaching and learning objectives. **Photogrammetry and Remote Sensing Laboratory** This lab houses a 30 seat computing space and specialist equipment space. The computing space is equipped with 15 PCs with access to ERDAS Imagine, ContextCapture, Agisoft PhotoScan, PhotoModeler, and Leica Cyclone v6.0 software. The specialist equipment space houses an Intergraph ImageStation DPW, an Intergraph PhotoScan TD, a dual screen Leica LPS DPW, a Peiss P3 analytical stereo plotter, and provides a workspace for laser scanning projects. The lab is also equipped with instruments and sensors for advanced research and development in photogrammetry and robotic vision, and a demonstration platform for planetary mapping and remote sensing research.

LSGI	**Remoted Sensing Laboratory** This lab aims to implement high-impact and high-quality research through cross disciplinary collaborations among faculties/schools and other UGC institutions, provide new insight into a wider range of research areas, and maximize their impact and benefit to society. Apart from continuing to focus on the environmental applications of the state-of-the-art remote sensing systems, as well as the development of techniques to enhance the usefulness of these systems, the lab also expands its research endeavours to the application of remote sensing technologies in teaching and learning. **Hydrographic Survey Laboratory** The hydro lab has evolved into a modern laboratory to meet various university teaching, research and consulting requirements. It has a suite of advanced instruments and software for teaching, research and consulting services. **Navigation Laboratory** Jointly set up by the Department and Nanjing University of Aeronautics and Astronautics (NUAA), the laboratory supports four main areas of research: integrated navigation systems; GNSS and positioning; and intelligent transportation systems (ITS) and location based services (LBS). **Laboratory for Deformation and Geohazards Studies** This lab facilitates research in developing new technologies such as GNSS (Global Navigation Satellite Systems), InSAR (Interferometric Synthetic Aperture Radar) and in-situ sensor-based technologies, and in studying geohazards such as landslides, earthquakes, land subsidence and structural health. The laboratory is equipped with advanced hardware and software. **JC STEM Lab of Earth Observations** The JC STEM Lab of Earth Observations is an effort of the PolyU, the Hong Kong Jockey Club Charities Trust, and the Hong Kong SAR government to support the “Global STEM Professorship Scheme”. The laboratory will focus on the development of original and innovative EO methodologies and technologies and their applications for studies of the causes, effects, and responses to environmental and societal challenges in cities and urban areas, with the goal of becoming a global research hub in EO.

C2. University Research Facilities

University Research Facility in 3D Printing (U3DP)

The University Research Facility in 3D Printing (U3DP) aims at providing all-round support for PolyU staff, researchers and students in applying various types of 3D printing technologies to excel their research works and academic study. It serves as a technology and knowledge hub of 3D printing technologies to unleash students' imagination for innovation and enhance their interest in design and make. It also opens up new initiative for research and industrial collaboration.

University Research Facility in Behavioral and Systems Neuroscience (UBSN)

The University Research Facility in Behavioral and Systems Neuroscience (UBSN) is a state-of-the- art think tank and interdisciplinary technological platform supporting the research endeavors of PolyU's principal investigators and researchers as well as those from other higher education institutions in Hong Kong. It serves as a key training hub for all who are pursuing scientific enquiry in neuroscience and related disciplines.

University Research Facility in Big Data Analytics (UBDA)

The University Research Facility in Big Data Analytics (UBDA) aims to provide an infrastructure with software tools and offer an open platform for cross-disciplinary collaboration among researchers and external partners to develop, support, service and sustain research into big data analytics. The UBDA infrastructure has 5 layers, including the Storage Layer, Network Layer, Computing Cluster Layer, Application Layer and Service Layer.

University Research Facility in Chemical and Environmental Analysis (UCEA)

The University Research Facility in Chemical and Environmental Analysis (UCEA) provides an interdisciplinary platform for chemical and environmental research with a total of 18 major equipment located in 9 different laboratories. The collection of cutting-edge equipment, ranging from high resolution mass spectrometer, solid state Nuclear Magnetic Resonance (NMR) spectrometer to third generation DNA sequencer, encourages the research atmosphere and nurture collaboration from experts in different background.

University Research Facility in Life Sciences (ULS)

The University Research Facility in Life Sciences (ULS) provides access to advanced instruments for conducting research in the life sciences, facilitating multidisciplinary research and innovations, maintaining core facilities, and training research staff and students.

University Research Facility in Materials Characterization and Device Fabrication (UMF)

The University Research Facility in Materials Characterization and Device Fabrication (UMF) serves as a catalyst for multidisciplinary education and innovations, coordinating activities, maintaining core and shared facilities, training students, and fostering collegial exchanges of expertise.

Appendix D: Contact of FRC and DRCs

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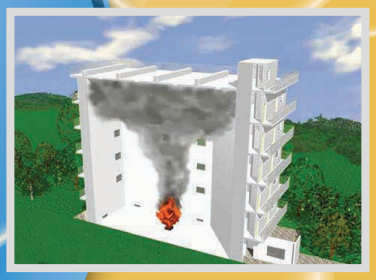

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