Faculty of Construction and Environment

Research Postgraduate Programme Requirement Document 2020/21

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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Department of Building and Real Estate (BRE)

Department of Building Services Engineering (BSE)

This Document is subject to review and changes which the programme 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 Regulations and Administrative Procedures for the Degrees of MPhil and PhD and the Research 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 internationally 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 scholarship. Students are encouraged 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 analyze 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 of 13 weeks, and a 7-week summer term. The academic year starts in early September, with the second semester ending sometime in April and the summer term running 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 joint PhD programmes leading to dual awards 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

[#] The normal period of study for these PhD students is based on the possession of a Master's degree with a significant research component, such as a dissertation, as determined by the Departmental Research Committee (DRC).

If a 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 study period. The DRC Chair shall act on the Chief Supervisor's recommendations to approve or disapprove the student's request for continuing his/her study beyond the normal study period (but within the maximum study period).

4. Admission

4.1. Admission Requirements

To register for the degree of MPhil, a student must hold:

- A Bachelor's degree with first or second class honours from a recognised university; OR
- Other academic qualifications which are deemed to be equivalent.

To register for the degree of PhD, a student must normally hold a postgraduate degree containing a significant research component, such as a dissertation, conferred by a recognised university.

In exceptional circumstances, applicants other than those stipulated above may be admitted directly to the PhD programme. For example, applicants with a Bachelor's degree with first class honours, or the equivalent. Such applicants may be required to pass an examination.

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 (with score for the writing component at 6.0 or above) 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 (with a writing score of 23 or above) or 550 or above for the paper-based test (with a score of 4 or above in the Test of Written English).

Alternatively, consideration will be given to acceptable scores in other internationally recognised public examinations, such as the Graduate Record Examination (GRE) or the Graduate Management Admission Test (GMAT).

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

4.3. Research Proposal & Supervisory Arrangements

A student registered for the degree of MPhil or PhD shall follow an approved programme of research and coursework under a Chief Supervisor and, if appropriate, Co-supervisors. With a view to providing both departments and newly-admitted research students opportunities to identify the most appropriate supervisors, there are two supervisory arrangements:

- The DRC assigns a Chief Supervisor and approves a student's detailed research proposal before the commencement of study.

- If the 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 affiliation with the department, the department is obliged to assign the most suitable staff member(s)

as supervisor(s) within four months of admission. The 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 *"Research Supervision Guidelines (Roles and Responsibilities)"* appended in the *Research Student Handbook* from the Research Office (RO) 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 programmes is 31 December each year. Applicants should submit an online application and settle the application fee before the application deadline via our 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 our eAdmission System to check their application status (e.g., notification of interview/test and admission offer).

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

5. Registration and Progress

Students have to commence their study at the start of Semester 1, Semester 2 or Summer Semester.

5.1. Confirmation of Registration

A successful applicant is provisionally registered as a full-time or part-time research degree student.

Within the first half of the normal period of study, a research student is required to have his/her registration confirmed, subject to a formal assessment. If the progress of the research study is satisfactory, the student's registration in the PhD or MPhil programme is confirmed.

Registered MPhil students can apply for transfer to PhD programmes during the process. Students who fail to complete their confirmation of registration within the first half of their normal period of study will be considered as not progressing satisfactorily, and may be de-registered from their study. [3]

5.2. Progress Monitoring

A 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 students will be assessed by their academic department by the end of each Semester. DRC is required to indicate in the Student Record System if an RPg student will be allowed to proceed on with their study by end of each Semester. [4]

5.3. Deregistration

A student may be deregistered in the following circumstances:

- if his/her progress is considered unsatisfactory; or
- if the maximum period of study is exceeded; 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.

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

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

With effect from 2018/19 cohort onwards, all RPg students are required to take and pass two English enhancement subjects, before thesis submission:

- ELC6001 "Presentation Skills for Research Students" and
- ELC6002 "Thesis Writing for Research Students".

For exemption, RPg students need to pass the Research Language Skills Assessment (RLSA).

6.2. Coursework/Credit Requirements

6.2.1. University Coursework Requirements

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	Coursework requirement	Details
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 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
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

**HTI6081 Ethics: Research, Professional & Personal Perspectives*

6.2.2. Faculty Compulsory and Elective Subjects

Research students of FCE are required to take Faculty compulsory subjects listed below:

- *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.

6.2.3. Practicum

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 Head of Department (HoD) or his/her delegate for 6 hours/week in any 13-week semester.

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

Full-time students are required to attend at least 10 research seminars per year for one credit, 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 for one credit, 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 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 full-time students) or per two years (for part-time students) to fulfill the research seminar credit requirement.

Please refer to “Coursework/Credit Requirements” of *Research Students Handbook* for the detailed requirements. [5]

6.2.5. Credit Transfer

Applications for the transfer of credits from recognised previous studies at postgraduate level will be endorsed by the DRC with justifications and approved by the HoD. 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. Transfer of credits taken at postgraduate level

outside PolyU after admission will also be endorsed and approved by the DRC and the HoD respectively.

6.2.6. Subject Exemption

A student may be exempted from taking a compulsory subject if he/she has successfully completed a similar subject previously in another programme or has already acquired the associated knowledge and skills via work experience, etc. Subject exemption is decided by the DRC, although students can also apply for it. If a student is exempted from taking a compulsory subject, the credits associated with the subject will not count towards the credit requirements. It will therefore be necessary for the student to take another subject, approved by the Chief Supervisor, to satisfy the credit requirements.

For regulations and procedures governing the credit transfer and subject exemption, please refer to the *Research Student Handbook*. [6]

6.2.7. Qualifying GPA Requirements

Research students need to fulfill their coursework/credit requirements with a stipulated qualifying GPA before they can submit the thesis for examination:

- All MPhil students need to complete their coursework with a qualifying GPA of 2.75 or above.
- All PhD students need to complete their coursework with a qualifying GPA of 3.0 or above.

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 work or non-PolyU laboratory work. Despite of the mode of study, the residence requirement for an MPhil degree is two regular semesters; and that for a PhD degree is three regular semesters if a relevant research Master's degree is earned prior to entering the programme, but four regular semesters if it is not. All research postgraduate students must fulfill the residence requirement before thesis submission. [7]

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

Where a student needs to conduct his/her research outside Hong Kong, adequate supervision arrangements must be proposed by the Chief Supervisor and approved by the DRC for study periods spent outside Hong Kong.

6.4. Thesis Requirements

On completion of an approved programme of study and research, students must submit a thesis before the end of their maximum period of study and defend it in an oral examination. If a student

is unable to complete his/her study within the normal period, he/she shall notify the DRC via the Chief Supervisor in writing before the normal period expires, indicating the expected completion date and the reasons for failing to submit the thesis within the normal period. Any research student who fails to submit his/her thesis by the end of the normal period of study is required to pay a continuation fee.

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 student's own account of his/her investigations and be an integrated and coherent piece of work. The thesis shall be presented in English. An intention to present the thesis in a language other than English will be considered, preferably on admission. 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. [8]

7. Award of Degree

The degree of Master of Philosophy (MPhil) or Doctor of Philosophy (PhD) shall be awarded to a student who, on completion of all stipulated coursework requirements and on 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.

8. Financial Assistantship

8.1. Hong Kong PhD Fellowship Scheme (HKPFS)

The Scheme, established by the Hong Kong Research Grants Council (RGC), aims to attract the best and brightest students in the world to pursue their PhD programmes in Hong Kong.

Successful applicants admitted to the PhD programmes at PolyU via the HKPFS will enjoy:

- an annual stipend of HK$309,600 (approximately US$39,700) for the entire normal study period
- a full waiver of tuition fees for the entire normal study period
- a conference and research-related travel allowance of HK$12,900 (approximately US$1,700) per year for the entire normal study period and
- an associated money of HK$20,000 per normal study year

The Scheme calls for applications in September each year. [9]

8.2. Studentship

The Studentship is a scholarship for full-time research students intended to be a means of financial support to allow them to fully focus on their studies. It shall be awarded on the basis of academic merit. A Studentship awardee will receive a stipend from the University on a monthly basis. Since the awardee is a full-time student and not an employee of the University, the award will not be subject to taxation.

The duration of the studentship is normally an academic year within the normal study period of a student. The provision of the Studentship is also subject to the awardee making satisfactory progress in his/her study and availability of funding.

8.3. Assistantship under the Teaching Postgraduate Studentship (TPS) Scheme

The main purpose of the Assistantship for Research Postgraduate (RPg) students under the Teaching Postgraduate Studentship (TPS) Scheme is twofold:

- to grant, on a merit basis, financial support to eligible full-time RPg students with a view to allowing them to fully focus on their studies; and
- to provide more teaching experience and training opportunity to interested RPg students in order to widen their exposure for the development of their academic career.

Only full-time RPg students who are not receiving a stipend will be eligible for receiving assistantship under TPS. Selected students for an assistantship under the TPS will be appointed as part- time Teaching Assistants (TA) at the University on terms and conditions in accordance with the University's policies on part-time appointment.

8.4. Scholarships

The Hong Kong Polytechnic University International Postgraduate Scholarships for PhD Studies

The Scholarships will be awarded to academically strong applicants who can contribute to the internationalisation of the PolyU and bring cultural diversity to the University through open competition. Subject to satisfactory progress in students' studies, the scholarship will cover the cost of tuition during the study period.

8.5. Associated Money and Conference Attendance Grant

All RPg students, irrespective of the funding source, will be provided with Associated Money during the normal study period (with a reference amount of HK$20,000/year for full-time students and HK$10,000/year for part-time students).

A maximum amount of Conference Attendance Grant of HK$20,000 may be granted for each application. There is no restriction on the number of times a student can be supported for conference attendance, as long as the total amount allocated to the student throughout his/her studies does not exceed HK$25,000.

9. Joint PhD Programmes Leading to Dual Awards

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 respectively by PolyU and the partner institution.

Students admitted under these programmes should refer to the *"Handbook for the Joint PhD Programmes Leading to Dual Awards"* for specific regulations and administrative procedures. [10]

9.1. Admission

Incoming students admitted should satisfy PolyU's minimum entrance requirements and English proficiency requirement. When applying for admission, the applicant must attach a research proposal and a study plan detailing the periods of study at PolyU and the partner institution. The research proposal and the study plan must be approved by both institutions.

Outgoing students of any disciplines are eligible for application. Normally, all full-time PhD students within the first half of the normal study period can apply. However, different partner universities may stipulate different requirements on the remaining time of the normal study period. These institution-specific requirements will be stated in the call for applications.

9.2. Period of Study and Residence Requirements

Incoming students are required to commence their study at PolyU at the start of either Semester 1 or Semester 2. They should follow the normal/maximum study period of regular RPg programmes offered by PolyU. They will base their studies at PolyU for a certain period (in terms of Semester), usually 3 consecutive semesters plus 1 summer term.

Outgoing students will base their studies at the partner institution for a certain period (in terms of Semester), subject to the residence requirements of the partner institution.

9.3. Academic Requirements

As a student will receive two parchments, and in the light of different programme requirements imposed by the partner institution on the joint PhD programme, the student is required to satisfy the programme requirements of both PolyU and the partner institution.

Students are required to complete one single piece of research to fulfill the award requirements of both universities and should observe the regulations and guidelines of both universities at all times.

9.3.1. Transfer of credits from Partner Institution

Credits taken at either of the two universities after admission to the joint programme shall be recognised by both universities. For subjects taken at the Partner Institution without a grade, the DRC shall assign an appropriate grade for the approval of the HoD which shall also vet the validity of the credits.

10. Research/Academic Attachment Opportunities

10.1. Research Student Attachment Programme

The Programme provides invaluable research experience and an opportunity for full-time MPhil and PhD students to add a global dimension to university life. Successful applicants will continue to receive studentship, if applicable, while continuing their research interests in a non-local host institution. Travel expenses will normally be supported based on the actual amount spent and will be capped at HK$10,000. A monthly subsistence allowance of HK$5,000 will be granted and the total amount for each applicant will be capped at HK$30,000.

Applications are also invited from in-coming visiting full-time PhD research students with substantial international exposure and the potential to contribute to the internationalisation of the University. A monthly subsistence allowance of HK$5,000 will be granted and the total amount for each successful applicant will be capped at HK$30,000.

The programme may range from a minimum of three months to a maximum of one year. Calls for applications are in September/October and March/April each year.

11. References

[1] *Research Supervision Guidelines (Roles and Responsibilities), Research Student Handbook*
https://www.polyu.edu.hk/ro/STDHBK/

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

[3] *Confirmation of Registration, Research Student Handbook*
https://www.polyu.edu.hk/ro/STDHBK/

[4] *Monitoring Progress, Research Student Handbook*
https://www.polyu.edu.hk/ro/STDHBK/

[5] *Coursework/Credit Requirements, Research Student Handbook*
https://www.polyu.edu.hk/ro/STDHBK/

[6] *Credit Transfer/Subject Exemption, Research Student Handbook*
https://www.polyu.edu.hk/ro/STDHBK/

[7] *Residence Requirement, Research Student Handbook*
https://www.polyu.edu.hk/ro/STDHBK/

[8] *Thesis Requirements, Research Student Handbook*
https://www.polyu.edu.hk/ro/STDHBK/

[9] *Hong Kong PhD Fellowship Scheme (Application via PolyU)*
https://www.polyu.edu.hk/ro/hkphd-fellowship/

[10] *Handbook for the Joint PhD Programmes Leading to Dual Awards**
https://www.polyu.edu.hk/ro/STDHBK-JointPhD/

* Only accessible to PolyU staff and student.

[Note: Regulations are currently being reviewed by the University and may be subject to changes. Updated version will be posted on the Faculty website at https://www.polyu.edu.hk/fce/publications/programme-prospectus]

Part II

FCE Research Postgraduate Programmes

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 application-oriented 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 analyze 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 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	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	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*

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 analyzing 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	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	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*

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	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	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*

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 analyzing 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	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	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*

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 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 analyzing 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 through the generation of new knowledge 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

4.5.2. Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	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	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*

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 analyzing 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	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	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*

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 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 analyzing 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 through the generation of new knowledge 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

4.7.2. Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	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	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*

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 analyzing 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	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	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*

Department of

***B**uilding **S**ervices **E**ngineering*

Department of Building Services Engineering

1. Introduction

The Department of Building Services Engineering (BSE) was officially established in December 1981, and has become one of largest BSE departments worldwide. As a leading provider of trained professionals in building services for the unique environment of Hong Kong, research in BSE focuses on the quality of the environment, energy efficiency 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 sanctuary from the elements and from the extremes of temperature, noise, light, toxins and pathogens at the lowest cost in energy and resources. It offers a range of undergraduate and postgraduate degree programmes serving the needs of local industry at various levels.

The research in the Department is comparable to those in the reputed universities worldwide in the discipline of Building Environment, as evidenced by research output reported by one of international notable ranking organizations. Expertise of BSE academic staff spans a wide range of areas, including various 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.

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 the knowledge, skills and abilities to perform a piece of investigative work of substance 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	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*

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 analyzing 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. <u>Curriculum Map</u>

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	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-BSE6102* 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*

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	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*

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 analyzing 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	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-BSE6102* 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*

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	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*

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 analyzing 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	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-BSE6102* 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*

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	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*

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 analyzing 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	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-BSE6102* 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*

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	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*

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 analyzing 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	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-BSE6102* 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*

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 the 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 of 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	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 Surface Water Quality Modeling and Reactor System	CSE6700-CSE6703* Attendance in Research Seminars/Workshops/Conferences 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*

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 analyzing 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 analyzing 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	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 Surface Water Quality Modeling and Reactor System	CSE6700-CSE6701* Attendance in Research Seminars/Workshops/Conferences 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 analyzing 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*

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	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	CSE6700-CSE6703* Attendance in Research Seminars/Workshops/Conferences 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			√	√			√	√		√	√		√
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 Construction and Transportation 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 Construction and Transportation			√	√	√			√		√	√		√

**Compulsory*

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 analyzing 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 analyzing 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	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	CSE6700-CSE6701* Attendance in Research Seminars/Workshops/Conferences 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 analyzing 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*

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	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 Surface Water Quality Modeling and Reactor System	CSE6700-CSE6703* Attendance in Research Seminars/Workshops/Conferences 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*

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 analyzing 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 analyzing 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	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 Surface Water Quality Modeling and Reactor System	CSE6700-CSE6701* Attendance in Research Seminars/Workshops/Conferences 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 analyzing 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*

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	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	CSE6700-CSE6703* Attendance in Research Seminars/Workshops/Conferences 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*

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 analyzing 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 analyzing 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	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	CSE6700-CSE6701* Attendance in Research Seminars/Workshops/Conferences 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 analyzing 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*

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	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	CSE6700-CSE6703* Attendance in Research Seminars/Workshops/Conferences 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*

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 analyzing 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 analyzing 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	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	CSE6700-CSE6701* Attendance in Research Seminars/Workshops/Conferences 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 analyzing 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*

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-scape 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

4.1.1. Curriculum Map

Intended Learning Outcomes	ELC6001* Presentation Skills for Research Students	ELC6002* Thesis Writing for Research Students	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	LSG652 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*

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 analyzing 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 analyze 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	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	LSG652 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 analyze 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*

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	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	LSG652 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*

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 analyzing 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 analyze 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	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	LSG652 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 analyze 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*

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 Health Technology and Informatics (HTI)	HTI6081[2]	Ethics: Research, Professional & Personal Perspectives
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 and Real Estate (BRE)	BRE666	Numerical Methods for Engineers
	BRE671-674[5]	Attendance in research seminars/workshops/conferences
	BRE675-676[6]	Practicum
Department of Building Services Engineering (BSE)	BSE6001	Computational Fluid Dynamics
	BSE6004	Fire Science and Fire Safety Engineering
	BSE6005	Indoor and Outdoor Environmental Quality Evaluation and Simulation
	BSE6101-6104[5]	Research Seminar I/II/III/IV
	BSE6105-6106[6]	Practicum I/II

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	Surface Water Quality Modeling and Reactor System
	CSE6015	Transportation Optimization and Simulation Methods
	CSE6700-6703[5]	Attendance in Research Seminars/Workshops/Conferences 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
	LSG641-642[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 Subject for full-time and part-time FCE research students who registered on/after 2 July 2014.*
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	HTI6081
Subject Title	Ethics: Research, Professional & Personal Perspectives
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 others • 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 • Recent ethical issues affecting Hong Kong and the society in general • Ethical use of information in thesis writing: understanding copyright, plagiarism and proper citation

<table>
<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 ananlysis</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:

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 individual, professions and societies benefit from following ethically acceptable behavior and practices.
Oral presentation will assess the students' ability to present and argue the points in support of their rational.

</td></tr>
<tr><td>tudent 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 research 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; Building Environmental Performance; Energy Efficient Building Technologies; 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.
Teaching/Learning Methodology	A group of academic staff from the four constituent 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.

<table>
<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>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>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>
</table>
</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. **Research thinking** Components and ways of creative thinking. Ways of thinking leading to great innovation. Ways of thinking by great scientists and inventors.

<table>
<tr><td></td><td>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.msubillings.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 ResearchMethods, 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 Modeling (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 initial 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 modeling 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 modeling and simulating heavy and highway construction, underground construction technologies, as well as earthmoving, building construction, and tunneling operations. Also, WebCYCLONE, STROBOSCOPE /EZSTROBE, Keystone, and CRYSTALBALL simulation packages will be introduced. **System Dynamics (SD)**: introduction to the principles of modeling 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 modeling 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. <u>Building Information Modeling (BIM):</u> • 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 topics 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 modeling 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 modeling and analyzing 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 topic of interest.

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	f
1. Quizzes	20%	✓	✓	✓		✓	✓
2. Project	40%			✓	✓	✓	✓
3. Test	40%	✓	✓	✓		✓	✓
Total	100%						

Student Study Effort Expected

Class contact:	
▪ Lecture	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

- 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 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.
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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 further 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 microbial fuel cells; Various batteries, such as Li-ion battery, Li-air battery, and Zn-air battery.
Teaching/Learning Methodology	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.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed					
		a	b	c			
1. Coursework	25%	✓	✓	✓			
2. Mini-tests	25%	✓	✓				
3. Oral Examination	50%	✓	✓	✓			
Total	100%						

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

*<u>*Oral Examination:*</u> 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.

Student Study Effort Expected

Class contact:	
▪ Lecture	20 Hrs.
▪ Tutorial	7.5 Hrs.
▪ Student seminar	6 Hrs.
▪ Test	2.5 Hrs.
▪ Examination	3 Hrs.
Other student study effort:	
▪ Reading of reference materials	60 Hrs.
▪ 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 Willey & 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. **Indoor and urban environment** 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. **Atmospheric pollution** 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 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. **Climate change** 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.

<table>
<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. 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. Colin Baird (2012) Environmental Chemistry, Fifth Edition, W. H. 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.shtml
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*.

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

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 analyzing 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 acquisition • 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 · Transportation · Traffic monitoring · Urban planning · Smart cities · logistics · Urban Infrastructure · Business · Internet of Things

<table>
<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. Assignment</td><td>30%</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>2. Class project</td><td>70%</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>39Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Reading of reference materials</td><td>52Hrs.</td></tr>
<tr><td>▪ Writing project report</td><td>39Hrs.</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 and **R**eal **E**state*

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 equations** – 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. 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

<table>
<tr><td></td><td>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></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="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>Hours/week x weeks</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>
<tr><td>Total student study effort</td><td>120 Hrs.</td></tr>
</table>
</td></tr>
<tr><td>Reading List and References</td><td>1. S.C. Chapra and R.R. Canale, Numerical Methods for Engineers, 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</td></tr>
</table>

	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. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 pas 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 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 full-time students) or per two years (for part-time students to fulfill 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. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 pas 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 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 full-time students) or per two years (for part-time students to fulfill 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. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 pas 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 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 full-time students) or per two years (for part-time students to fulfill 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. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 pas 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 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 full-time students) or per two years (for part-time students to fulfill 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 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 earn one credit, students will be 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. 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. Stipend recipients are allowed to fulfill part of their Practicum requirement through the completion of these compulsory training credits. 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, 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	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 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 earn one credit, students will be 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. 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. Stipend recipients are allowed to fulfill part of their Practicum requirement through the completion of these compulsory training credits. 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, 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 **S**ervices **E**ngineering*

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 5.3 One Equation models, two equation models, esp. k-ε model 5.4 Reynolds stress equation models 5.5 Large eddy simulation (LES) and Direction solution of N-S equations 6. Boundary conditions, the log-wall function method.

<table>
<tr><td></td><td>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 assessment
- Case study (mini-project)
- Seminar presentation</td><td>
30%
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="5"></td></tr>
</table>
</td></tr>
<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td>Hours/week x weeks</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 6.1 Pre-Flashover Fires 6.2 Post-Flashover Fires 7. Structure Performance under Fire

<table>
<tr><td></td><td>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><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. 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>2. Midterm</td><td>20%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>3. 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>
</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>2 × 11 = 22 Hrs.</td></tr>
<tr><td>▪ Seminar/Presentation</td><td>1 × 7 = 7 Hrs.</td></tr>
<tr><td>▪ Tutorial</td><td>1 × 10 = 10 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Project</td><td>3 × 8 = 24 Hrs.</td></tr>
<tr><td>▪ Self-study</td><td>5 × 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.</td></tr>
</table>

	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. 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 environment 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. **Indoor environmental quality in relation to building design:** 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. **Outdoor environmental quality in relation to building design** Introduction to outdoor environment in terms of acoustics (e.g. CRTN 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. **Rating of indoor and outdoor environmental performance** BEAM Plus and LEED. Indoor environmental quality management strategies. Assessment of indoor and outdoor environment.

<table>
<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 Services Engineering and are expected to last not less than an hour each. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 Services Engineering and are expected to last not less than an hour each. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 Services Engineering and are expected to last not less than an hour each. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 Services Engineering and are expected to last not less than an hour each. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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: 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.

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 making 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. <u>Material nonlinearity and constitutive models for metals</u>

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 and geo-materials

Elastic-plastic behavior of concrete, rock and soils; Yield surfaces for concrete and geo-materials; Rate effects; Drucker-Prager model; Mohr-Coulomb model; Cam-Clay Models; Yin and Graham's Elastic Visco-Plastic Model; Brief introduction to geotechnical finite element programs (SIGMA/W and PLAXIS).

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 opportunities 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)] and 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:	
	▪ Lectures	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 Mathematica 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. Muir Wood, D. (1990) Soil behaviour and critical state soil mechanics, Cambridge University Press. Potts, D. M. and Zdravkovic, L. (1999) Finite element analysis in geotechnical engineering – theory", Thomas Telford Publishing Ltd, U.K. 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. PLAXIS 2D (2015 Version), from PLAXIS, Delft, The Netherlands, (http://www.plaxis.nl/). SIGMA/W (December 2014 release), from Geo-Slope International, Calgary, Canada (http://www.geo-slope.com).

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 a understanding of the basic theory and practical use of health monitoring system 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) 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

Teaching/Learning Methodology

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.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed					
		a	b	c	d		
1. Assignments	30		✓	✓			
2. Project report	40	✓	✓	✓	✓		
3. Project presentation	30	✓	✓	✓	✓		
Total	100 %						

Student Study Effort Required

Class contact:	
▪ Lectures/Tutorial	30 Hrs.
▪ Project/Laboratory/Presentation	9 Hrs.
Other student study effort:	
▪ Reading and studying	48 Hrs.
▪ Completion of reports	30 Hrs.
▪ Total student study effort	117 Hrs.

Reading List and References

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).
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) Zienkiewicz, 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 behavior 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 behavioral analysis
Intended Learning Outcomes	Upon completion of the subject, students will be able: a. to apply the knowledge about the behavior 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 behavior (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 engineering.

<table>
<tr><td></td><td>
<u>iv) Pavement structure and materials (1 week)</u>

Introduction to pavement type and structure; rheological properties and characterization of bitumen and bituminous materials.

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

<u>vi) 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 Assessment</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>
</table>

Student Study Effort Required	Class contact:	
	▪ Lectures	39 Hrs.
	▪ Examination	--
	Other student study effort:	
	▪ Reading of reference materials	36 Hrs.
	▪ 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 0 415 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).

Al-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 **Manuals** 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 behavior; d. to implement modern repair and strengthening technology for upgrading deteriorated concrete structures; e. to hold knowhow on the recycling and management of construction wastes.
Subject Synopsis/ Indicative Syllabus	This subject covers the following contents: 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. Diagnosis, inspection and performance assessment
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. Repair and strengthening
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. Life-end strategies and environmental issues
Concrete recycling, recycling of glass, carbon footprint evaluation

6. Exemplary life cycle performance management tools
Bridge management, building management, port structure management, pavement management, tunnel management.

Teaching/Learning Methodology

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.

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	50%	✓	✓	✓	✓	✓
2. Quiz	20%	✓	✓	✓	✓	✓
3. Project Report and Oral Examination	30%	✓	✓	✓	✓	✓
Total	100 %					

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), e) and f). 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.	
Student Study Effort Expected	Class contact:	
	▪ Lectures	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	• **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) Gj□y, 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 – 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	Surface Water Quality Modeling and Reactor System
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.
Objectives	1. To provide students a better understanding of the mechanisms leading to various types of water quality behavior. 2. To provide students a rational basis for devising water quality control strategies. 3. To provide students with the knowledge about the fundamental reaction kinetics and methods of analysis data collected from laboratory results. 4. To provide students with in-depth analysis and design ability of common water reactors and solutions to real problems.
Intended Learning Outcomes	Upon completion of the subject, students will be able: a. to formulate and develop mathematical models for water quality prediction b. to devise suitable measures for water quality control 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 methods and solutions
Subject Synopsis/ Indicative Syllabus	**Keyword Syllabus** 1. Basic Concepts in Water Quality Management: waste load allocation, concentration and dilution, mass balance, mass transport. 2. Diffusion and Dispersion Processes: molecular diffusion, advective diffusion, turbulent diffusion, longitudinal shear flow dispersion, some useful solutions of the advective diffusion equation. 3. Mixing in Rivers and Estuaries: river hydrology, tidal phenomena in estuaries, mixing processes, water quality parameters, simple models for water quality in rivers and estuaries, engineering controls. (The sections 1-3 are provided by Hydraulic Unit) 4. Reaction Kinetics: the introduction of common reaction kinetics (such as zero order, first order, and the others) for the use in the reactor system. 5. Reactor Hydraulics: flow distribution, flow in pipes, flow in open channels. 6. Hydraulic profiles: develop the hydraulic profile in a reactor involving the use of pumps, gravity flow, front/side weir, and branched channels in various inlet and outlet arrangement. (The sections 4-6 are provided by Environmental Unit)
Teaching/Learning Methodology	1. Lectures to deliver teaching materials. Lectures will provide fundamental methods and practical design approaches to the students, so that the

students can achieve design goals through the optimization of the function of the studied issues.

2. Students should explore journal papers on new methods, advanced techniques or basic theory related to the subject content and their previous background.
3. Tutorials will provide chances to the students to discuss their individual reactor design in details 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.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed					
		a	b	c	d		
1. Assignments	30%	✓	✓				
2. Quiz	20%	✓	✓				
3.Project report	50%			✓	✓		
Total	100 %						

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

Continuous assessment is based on

1) Assignments and a quiz on water quality modeling (50%).

2) Report on the design or analysis of a special reactor in the student's research field (50%).

Student Study Effort Required

Class contact:	
▪ Lectures and Tutorials	39 Hrs.
▪ Examination	--
Other student study effort:	
▪ Reading of reference materials	36 Hrs.
▪ Assignments	30 Hrs.
▪ Project	30 Hrs.
▪ Total student study effort	135 Hrs.

Reading List and References

Books

Chapra, S.C., Surface Water Quality Modeling, Waveland Press, Inc.

Thomann, R.V. and Mueller, J.A., Principles of Surface Water Quality Modeling and Control, Harper Int. Ed.

	Fischer, et al., Mixing in Inland and Coastal Waters, Academic Press. Metcalf & Eddy, Wastewater Engineering, Collection and Pumping of Wastewater, McGraw-Hill. Metcalf & Eddy, Wastewater Engineering, Treatment and Reuse; McGraw-Hall. **Journals** Water Research Environmental Science and Technology Chemical Engineering Research and Design Journal of Environmental Engineering, ASCE

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. <u>Fundamentals</u> 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. <u>Network Flow Optimization</u> Shortest path problems; vehicle routing problems; Traffic assignment problems (user equilibrium versus system optimal); Stochastic traffic assignment problems; Traffic assignment algorithms 3. <u>Network Design Problems</u> 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. <u>Complex System Problems</u> Agent-based modeling; System dynamics; System of systems; Network theory

<table>
<tr><td></td><td>5. Advanced Topics
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="4">Intended subject learning outcomes to be assessed</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td></tr>
<tr><td>1. Assignments</td><td>50%</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></tr>
<tr><td>Total</td><td>100 %</td><td colspan="4"></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:</td></tr>
</table>

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 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 Behaviour and 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	CSE6700
Subject Title	Attendance in research seminars/workshops/conferences 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. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 the Research Office for custody at the end of each academic year. Students should be awarded one credit per year (for full-time students) or per two years (for part-time students) for completing the above-mentioned requirement, with an overall assessment grade of Pass and Fail.
Reading List and References	Nil

Subject Description Form

Subject Code	CSE6701
Subject Title	Attendance in research seminars/workshops/conferences 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. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 the Research Office for custody at the end of each academic year. Students should be awarded one credit per year (for full-time students) or per two years (for part-time students) for completing the above-mentioned requirement, with an overall assessment grade of Pass and Fail.
Reading List and References	Nil

Subject Description Form

Subject Code	CSE6702
Subject Title	Attendance in research seminars/workshops/conferences 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 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. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 the Research Office for custody at the end of each academic year. Students should be awarded one credit per year (for full-time students) or per two years (for part-time students) for completing the above-mentioned requirement, with an overall assessment grade of Pass and Fail.
Reading List and References	Nil

Subject Description Form

Subject Code	CSE6703
Subject Title	Attendance in research seminars/workshops/conferences 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. The research seminars may or may not be organised by the host department and are expected to last not less than an hour each. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 the Research Office for custody at the end of each academic year. Students should be awarded one credit per year (for full-time students) or per two years (for part-time students) for completing the above-mentioned requirement, with an overall assessment grade of Pass and Fail.
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 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/research supporting activities 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 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. Stipend recipients are allowed to fulfill part of their departmental training requirement through the completion of these compulsory training credits. 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 (for details, please refer to item 10 below).
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 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/research supporting activities 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 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. Stipend recipients are allowed to fulfill part of their departmental training requirement through the completion of these compulsory training credits. 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 (for details, please refer to item 10 below).
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. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 the Research Office for custody at the end of each academic year. Students are recommended to complete one credit per year (for full-time students) or per two years (for part-time 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 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. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 the Research Office for custody at the end of each academic year. Students are recommended to complete one credit per year (for full-time students) or per two years (for part-time 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 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. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 the Research Office for custody at the end of each academic year. Students are recommended to complete one credit per year (for full-time students) or per two years (for part-time 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 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. The topic of the seminar reported on should not be related directly to the thesis title of the student.
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 the Research Office for custody at the end of each academic year. Students are recommended to complete one credit per year (for full-time students) or per two years (for part-time 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 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 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. 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 fulfill 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 fulfill 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 assessment 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 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. 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 fulfill 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 fulfill 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 assessment 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

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

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>
</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>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).</td></tr>
</table>

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 *(Note 1)*	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 *(Note 2)*	• 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 *(Note 3)*	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.

Assessment Methods in Alignment with Intended Learning Outcomes
(Note 4)

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed					
		a	b	c	d		
1. In-class test	30%	✓	✓	✓	✓		
2. Project report	30%	✓	✓	✓	✓		
3. Assignment	40%	✓	✓	✓	✓		
Total	100%						

Student Study Effort Expected

Class contact:	
▪ Lecture	26 Hrs.
▪ Lab/Tutorial	13 Hrs.
Other student study effort:	
▪ Reading of reference materials	39 Hrs.
▪ Writing project report	39 Hrs.
Total student study effort	117 Hrs.

Reading List and References

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. Foody (eds), Sage Publications.

Part IV

Appendices

Appendix A: Research Committees

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

A1. Research Committee (RC)

The Hong Kong Polytechnic University Research Committee (RC), a Committee of the Senate, is responsible for, amongst other things, developing research and research-degree policies, regulations and procedures; allocating research funds; and monitoring the progress and quality of research.

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. 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.

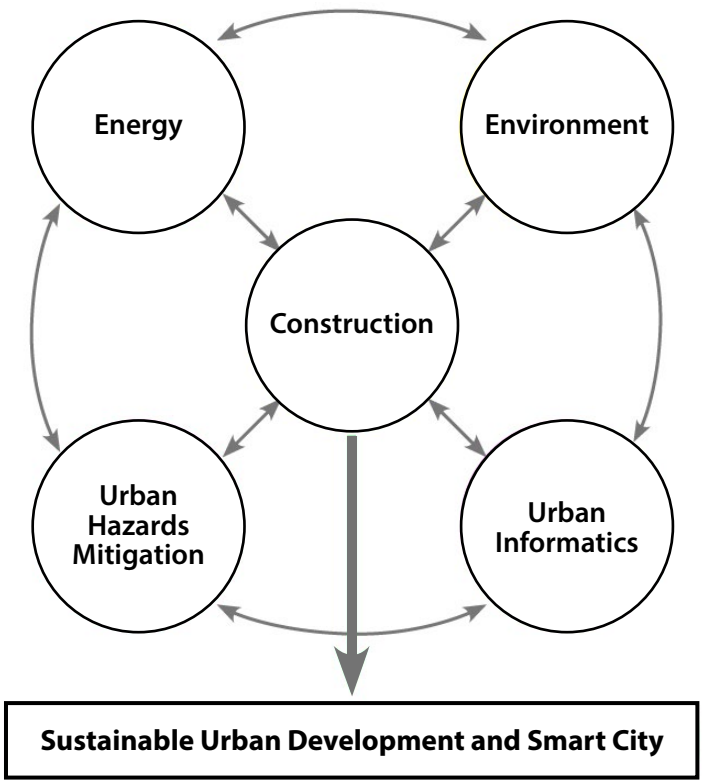
A3. Departmental Research Committee (DRC)

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 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 Building Services Engineering (BSE)
http://www.bse.polyu.edu.hk/

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 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. Recently, 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 big data.

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 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. **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. **Multimedia Communication Centre** The Multimedia Communication Centre (MMCC) is an ideal learning platform for staff and students to develop their multimedia skills by providing a comprehensive set of multimedia equipment, the latest software, technical support and training programmes. **Project Studios** The two studios are interconnected with a sliding partition, so they can be used either as two separate rooms or combined into one. They are designed to provide specialist teaching rooms for group project work using the tools of the trade commonly found in construction firms. **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.

Department of Building Services Engineering (BSE)

BSE	**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. **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 heat and humidity by different types of air handling equipment. Fans are used to distribute the conditioned air to various interior zones of a building through air ducts. In the HVACR lab, students can study the operating characteristics of fans and the air-flow disturbance along an air duct using the Fan Test Rig and the Air Duct and Damper Test Rig. Other experimental equipment includes a Refrigeration Laboratory Unit, a Bench Top Cooling Tower and an Air Conditioning Laboratory Unit. **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 in occupied spaces, on air-side systems, etc. The manikin is an important piece of equipment for investigating thermal comfort and indoor air quality. Integrated analysis of the data

BSE	in different areas such as thermal comfort, indoor air quality and subjective human responses can be carried 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 Honeywell IB system, a full set of Schneider automation systems, a variety of measurement instruments for building energy auditing and high-performance computers. 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. **Low-carbon Building Technology Laboratory** The Low-carbon Building Technology Laboratory consists of a stainless-steel cladded

BSE	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.

Department of Civil and Environmental Engineering (CEE)

CEE	The Department manages 26 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** - Hong Kong Road Research Laboratory - Transport and Highway Engineering Laboratory **Environmental Engineering Unit** - Advanced Environmental Microbiology Laboratory - Air Pollution Laboratory - Bioenergy Research Laboratory - Atmospheric Research Laboratory - Carbon Analysis and Filter Handling Clean Room - Environmental Chamber - Noise 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 - Soil Mechanics Laboratory - Rock Mechanics Laboratory **Hydraulic Engineering Unit** - Hydraulics Laboratory - Hydraulics Laboratory (Eco-hydraulics Research Center) - Hydraulics Laboratory (Sensors Development Office) **Structural Engineering Unit** - Concrete Materials Laboratory - Concrete Technology Laboratory - Light Structures Laboratory - Structural Engineering Research Laboratory - Structural Dynamics Laboratory - Structural Health Monitoring 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. **Laboratory for Geographic Information Systems** This lab supports teaching and research on geographic information science and systems; spatial data capture, process, query and analysis; and geo-visualisation. **Photogrammetry and Remote Sensing Laboratory** This lab houses a 30-seat computing space and a laser scanning and specialist equipment space. The computers are connected to the departmental domain and provide access to ERDAS Imagine 2015, Agisoft PhotoScan, PhotoModeler 2015 and Leica Cyclone. The specialist equipment includes an Intergraph ImageStation DPW, an Intergraph PhotoScan TD, a dual screen Leica LPS DPW and a Peiss P3 analytical stereo plotter. The lab also provides workspace for laser scanning projects.

LSGI	**Cadastre Survey Laboratory** This lab holds various district demarcation sheets, survey sheets and land records from the 1960s up to the present. The Cadastre lab has an A2 scanner and a 3D aerial photo-viewing device. **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). **Remote Sensing Laboratory** Remote Sensing Laboratory is newly established under the Department of Land Surveying and Geo-Informatics, The Hong Kong Polytechnic University and is a continued effort of the Department's Remote Sensing Research Group. It is located at ZB213 of Block Z of the University. The Laboratory 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 Laboratory also expands its research endeavours to the application of remote sensing technologies in teaching and learning. The recent initiatives of the Laboratory include the use of remote sensing and GIS in urban heat island effect, vegetation and ecosystems, spectral mixture analysis, dust aerosol retrieval, water and air quality monitoring, smart city tree management, artificial intelligence, and the use of iBeacon technology for engaging teaching and learning experiences.

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: Contacts of FRC and DRCs

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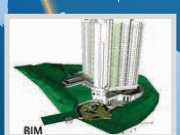

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