

## Subject Description Form

Subject Code	<b>BSE3713</b>
Subject Title	<b>Research Methods in Building Services Engineering</b>
Credit Value	3
Level	3
Pre-requisite Co-requisite Exclusion	Nil Nil Nil
Objectives	<p>To develop an understanding of scientific research methods and to critically examine their application in a particular aspect of Building Services Engineering (BSE).</p> <p>To develop sufficient expertise to adopt and use an appropriate research strategy to undertake a research investigation.</p> <p>To know the techniques necessary for collecting, presenting, synthesizing and analyzing data.</p> <p>To acquire knowledge required for a research proposal.</p> <p>To prepare research proposal,</p>
Intended Learning Outcomes	<p>Upon completion of the subject, students will be able to:</p> <ol style="list-style-type: none"> <li>a) appreciate the conventional methods for carrying out research in building services engineering, including basic principles including setting up and preparing physical and numerical experiments, surveys, the data acquisition and the error analysis;</li> <li>b) understand the process of research investigation;</li> <li>c) understand common data analysis technique in engineering and choose appropriate analysis methods, and</li> <li>d) prepare research proposal ethically, systematically and scientifically.</li> </ol>
Subject Synopsis/ Indicative Syllabus	<p><b>Research ethics:</b> Organizations, control and ethics committees, intellectual ownership and plagiarism, acknowledgement and citation, responsibility and accountability of researchers, data and interpretations, safety issues, sensitive materials, human subject, data storage, dissemination and disposing of records, case study.</p> <p><b>Basic techniques and research methods:</b> Desktop study and literature review. Research methodologies suitable for application in BSE. Measurement and data, measurement systems and experiment designs, sampling, validity of measurement, errors and calibration, dynamic measurement, systems with electrical signals, computerized data acquisition, data sampling technique, dimensions and units, similarity, time-series, dynamic behavior. Selection of instruments for measurement, resolution and measurable range, data logging and retrieval.</p> <p><b>Data analysis:</b> Statistical approach including central tendency, dispersion, probability, parameter estimation, outliers, regression analyses and correlations, frequency analysis. Parametric and sensitivity analysis, hypothesis tests, solutions of systems of equations including iteration method.</p> <p><b>Uncertainty analysis:</b> Uncertainty propagation, bias, sources of elemental error, single- and multi-sample measurements, digital data acquisition, systematic and random errors, multi-order uncertainty.</p> <p><b>Common parameters in BSE research agenda:</b> Acoustic and noise control, Building automation, Built environment, Electrical engineering, Energy saving for buildings, Facilities engineering and management, Fire and safety, Indoor environmental quality, Refrigeration, Renewable and sustainable energy, Ventilation and air-conditioning, Water supply and drainage.</p> <p><b>Planning and documenting experiments:</b> Problem definition, experiment design and preparation, data gathering and analysis, interpretation of data and reporting, dimensional analysis, uncertainty analysis, shakedown tests, sequencing and test matrix, scheduling, design review and documentation of experimental activities.</p>

**Teaching/Learning Methodology**

A project-based teaching approach is adopted for this subject to achieve the intended learning outcomes. Students are required to get involved in a project supported by lectures and workshops series

The lectures aim to introduce students on research ethics, fundamental principles, application of theories, research methods and experimental design, literature reviews, data and uncertainty analysis methods, and research planning. Students will be required to do assigned-readings, particularly on the fundamentals, before attending lectures. The assigned readings will be detailed in the teaching scheme to be distributed to students at the beginning of the Semester.

The workshops aim to allow students to work on solutions of exemplary BSE-related research problems via discussion with subject lecturers and among themselves.

After the lectures and workshops, the students, based on their background and interests, can choose to work on different topical areas. They will be assigned with a research supervisor with the research focus same as the students selected. Students will be guided to prepare a research proposal after carrying out an extensive literature review on the topic he/she selected, identifying the research objectives, developing the research methods, and establishing a feasible plan.

Throughout the project development process, the research supervisor will meet with the student on a weekly basis to guide and monitor the students' project works. Based on the tasks and the milestone dates agreed between the supervisor and the students, the supervisor will assess the project progress

**Assessment Methods in Alignment with Intended Learning Outcomes**

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)									
		a	b	c	d						
Assignment	30	✓		✓							
Project progress	20	✓	✓	✓	✓						
Project proposal	50	✓	✓	✓	✓						
Total	100										

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

The written assignment serves to examine the students' learning outcome in the design principles for research investigation, problem analysis and solving capabilities.

Project progress is assessed during the weekly supervisor meetings. Students are expected to present to the supervisor the plans and progress of the studied topic, and to respond to comments/questions of the supervisor.

The project proposal serves to assess all outcomes. Each student is required to prepare a research proposal for their final year BSE4725 Capstone Research Project. The project proposal should aim to place the research study into the right context and scope of work. It should include a critical review of relevant literature, a clear and precise objective, and a carefully designed methodology, a detailed and feasible research plan and the possible deliverables. The deliverables aim to make practical applications.

The students will be returned with feedbacks and comments for refining their proposal.

**Student Study Effort Expected**

Class contact:	
Lectures	9 Hrs.
Workshops	12 Hrs.

	Supervisor meetings	7 Hrs
	Other student effort	90 Hrs.
	Total student study effort	118 Hrs
Reading List and References	<p>A.J. Wheeler, A.R.Ganji, Introduction to engineering experimentation, NJ, Prentice Hall, 2010.</p> <p>Scott A. Gold, Research Methods in Science and Engineering, CRC Press 2016.</p> <p>Technical publications include:</p> <ul style="list-style-type: none"> <li>• Academic journal articles</li> <li>• Conference proceedings</li> <li>• WHO guidelines on indoor environmental pollution.</li> <li>• ASHRAE Standards and Handbooks.</li> <li>• CIBSE guides on design and operation.</li> <li>• NFPA Standards and Handbooks.</li> <li>• BS, ISO and IEC Standards.</li> <li>• Codes of practice, Hong Kong Government.</li> </ul>	