Subject Description Form

Subject Code	BSE521
Subject Title	Air Conditioning Control and Operation
Credit Value	3
Level	5
Pre-requisite/ Co-requisite/ Exclusion	Nil (Background knowledge of thermodynamics, heat transfer and fluid mechanics fundamental as normally covered in an engineering first degree or equivalent is preferred. ~~Working experience in air-conditioning is preferred.~~)
Objectives	To provide building services postgraduates with both fundamental and enhanced knowledge and practical experiences of the technical, environmental and economical aspects related to the operation of air conditioning systems.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a. critically review performance of airside of HVAC systems in air-conditioned buildings, taking into consideration the characteristics of the premises, ventilation requirement and limitation of the systems; b. critically review chilled water distribution systems in buildings, taking into consideration the pumping characteristics and part-load operation; c. apply control methods in airside and waterside of HVAC systems based on operational requirement of the systems; d. evaluate air conditioning system operation and performance with respect to thermal environmental conditions and energy requirement; e. critically comment on the control requirement, controllability and energy efficiency in the operation of air conditioning systems.
Subject Synopsis/ Indicative Syllabus	The focus of the subject is on operational requirement and control of air conditioning, directing to evaluate their operation and performance with respect to the indoor environmental conditions and energy efficiency. **Air conditioning fundamentals:** air conditioning cycles, system design considerations, system characteristics, part-load and year-round operation, system performance and operational problems, evaluation and comparison of systems. **Ventilation and ventilation systems:** ventilation requirement, contaminant decay, ventilation rate and risk of draft outdoor air supply in multi-zone systems, ventilation effectiveness, fan duct network analysis, operation of fan-duct systems, space pressurization. **Chilled water systems and control:** refrigeration cycle, chiller and pump performance, constant and variable chilled flow systems, primary and secondary water loops, variable primary only system, optimal design and sizing and balancing/commissioning, multiple chiller plant sequence control, control of heat rejection systems, pump speed and sequence control of chilled water systems, optimal control. **Air-side systems and control**: fan-coil system, constant air volume (CAV)

<table>
<tr><td></td><td>system, variable air volume (VAV) system, systems of independent humidity and temperature controls, design for energy efficient operation, space air temperature, humidity and space pressure controls as well as their coordination, ventilation control and demand control ventilation, enthalpy control and free cooling, system control and optimization.</td></tr>
<tr><td>Teaching/Learning Methodology</td><td>The subject provides a condensed course on air conditioning systems, specifically for engineering graduates who have not taken previously formal courses on air conditioning systems. Learning is facilitated through the following approaches:

• Fundamentals are covered by brief reviews and self-study guides.

• Enhanced materials are covered in lectures. Tutorials are arranged within lectures wherever appropriate to allow free discussions and clarification of queries.

• Student-centered case studies are organized to facilitate findings that may not be readily appreciated from books and sharing of experience gained from work. Critical analysis on the operation and control of specific air conditioning sub-systems is facilitated through case studies based on real system drawn from the work experience of the participants or from relevant cases reported in the literature/web. Inter-communication and sharing of experience among the participants are encouraged.

• Selected experimental investigation is arranged to provide hand-on experience on system operation and control and facilitate findings that may not be readily appreciated from books.</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. Tutorial problem assignments</td><td>0%</td><td>✓</td><td>✓</td><td></td><td>✓</td><td></td><td></td></tr>
<tr><td>2. Experimental investigation</td><td>15%</td><td>✓</td><td></td><td></td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>3. Assignment: Reading comprehension and critical review</td><td>10%</td><td>✓</td><td></td><td></td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>4. Case study</td><td>15%</td><td></td><td></td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>5. End-of-semester examination</td><td>60%</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td></td></tr>
<tr><td>Total</td><td>100%</td><td colspan="6"></td></tr>
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Explanation of the appropriateness of the assessment methods in assessing the intended learning outcomes:

Tutorial problems are distributed to students to practice solving air conditioning problems. Selected problems will be discussed in tutorial</td></tr>
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	sessions, and students are required to tackle those problems as homework before attending the tutorial sessions. Case study is to enable students to evaluate the operation and performance of air conditioning system with respect to the indoor environmental conditions and energy requirement, comment on the control requirement and energy efficiency critically, and propose measures for improvement. Experimental investigation is to allow students to practice application of the theories and appreciate the importance of operation and control of air conditioning systems on environmental and energy performance. The end-of-semester examination assesses students' ability in solving and rationalizing problems on air conditioning systems by applying their knowledge gained from the subject.
Reading List and References	ASHRAE Handbook 2019: HVAC Applications, Chapter 47: Design and Application of Controls. ASHRAE Standard 55-2020. *Thermal Environmental Conditions for Human Occupancy*. ASHRAE Standard 62.1-2019, *Ventilation for Acceptable Indoor Air Quality*. Haines, R.W. & Hittle, D.C. (2006). *Control Systems for Heating, Ventilating and Air Conditioning*, Boston: Kluwer Academic Publishers, 6th Ed. Kreider, J.F. Curtiss, P.S. & Rabl, A. (2010). *Heating and Cooling of Buildings: Design for Efficiency*, CRC Press/Taylor & Francis, Rev. 2nd Ed. McQuiston & Parker, (2005). *Heating, Ventilating, and Air Conditioning Analysis and Design*, Wiley, 6th Ed. *Study guide on air conditioning systems*, Department of Building Services Engineering, The Hong Kong Polytechnic University. Wang, S.W. (2010) Intelligent Buildings and Building Automation, Chapter 8 & 9, Spon Press (Taylor & Francis), London.