Subject Description Form

Subject Code	**BSE3225**
Subject Title	**HVACR I**
Credit Value	3
Level	3
Pre-requisite Co-requisite Exclusion	BSE2216 or BSE2280 or equivalent. Nil Nil
Objectives	This subject aims at: 1. equipping students with the abilities required in designing air conditioning systems for buildings, taking into consideration the heating and cooling load characteristics of buildings and performance characteristics of the air-conditioning systems with an emphasis on both the design and the part-load performance of the systems; and 2. developing their competence in making relevant decision that complies to requirement on energy efficiency of buildings and air-conditioning systems.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: a) apply knowledge of psychrometry to analyze heat and moisture transport in air-conditioning processes and cycles; b) estimate the contributions of various sources of heat gains and losses to the design cooling and heating loads of zones and buildings; c) determine ventilation requirements for occupants with reference to the principles of ventilation; d) determine duty and power demand of fans in HVAC air handling and distribution taking into consideration energy loss and efficiency of the systems; e) critically review performance of airside systems with constant air volume (CAV) control and variable air volume (VAV) control for premises within buildings, taking into consideration the characteristics of the premises and the limitations of the systems; and f) apply the control methods in the airside of HVAC systems.
Subject Synopsis/ Indicative Syllabus	**Psychrometry:** thermodynamic and transport properties of dry air, water vapour and moist air, including dry-bulb and wet-bulb temperatures, pressure, moisture content, vapour pressure and relative humidity; Gibbs-Dalton law; specific heat and enthalpy of moist air; evaporation, condensation and saturation; sensible and latent heat. **Psychrometric processes and cycles:** sensible heating and cooling, cooling and dehumidification, humidification and adiabatic saturation; thermodynamic wet-bulb temperature; conventional all air cycle; supply flow rate and cooling coil load determination. **Cooling and heating load calculation:** Sources of heat gains; building heat balance, ASHRAE's cooling load calculation method; cooling load and heat extraction rates; concept of radiant time series method; cooling load due to conduction heat gain through building envelope; cooling load due to solar heat gain; cooling load due to internal heat gains; ventilation and infiltration load; OTTV as an indicator of building envelope thermal performance, OTTV code requirements; measures for enhancing building envelope thermal performance; Heating load estimation. **Ventilation:** mechanical ventilation; ventilation requirements; space pressurization; fan-duct network; ventilation noise; energy code requirements. **HVAC air handling and distribution:** CAV systems, requirements for air conditioning and independent zone temperature control, methods of control, part-load performance characteristics; Fan-coil systems, local fresh air intake and centralized fresh air supply, advantages and limitations; VAV systems, turn-down ratio, methods of control, part-load performance characteristic, terminal reheat, skin CAV/VAV, dual duct VAV, economy cycle and controls; Energy code requirements on air handling and distribution, comparisons between VAV and CAV.

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<tr><td>Teaching/Learning Methodology</td><td>
Assigned reading with post reading investigative exercises to enable students to know about the background and fundamental of topics before attending the lectures.
Lecture to explain the theories and to deliver the main thrust of materials on psychrometry, air conditioning cycles, ventilation requirement and air conditioning systems.
Tutorial – tutorial problem sheets issued for students to solve numerical problems. Selected problems from the tutorial problem sheets will be discussed in tutorial sessions. Students are required to tackle those problems as homework before attending the tutorial sessions.
Mini design project – to allow students to practice load calculation using software such as EnergyPlus, schematic design of air conditioning systems, through a student-centered learning approach.
Laboratory work – to allow students to practice application of the theories and acquire a basic competence in system commissioning skills. There are two 3-hour laboratory sessions on HVACR experiments, arranged in small groups collectively with other core subjects. The experiments to be carried out are:

Air conditioning processes
VAV system performance test
Ventilation noise assessment

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<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 (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td></tr>
<tr><td>Tutorial problem assignments</td><td>0</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>Laboratory work</td><td>10</td><td>✓</td><td></td><td>✓</td><td>✓</td><td></td><td></td></tr>
<tr><td>In-class test</td><td>18</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mini design project</td><td>12</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td>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:
Design project assignment is to enable students to develop critical thinking and analysis on air conditioning systems and present their design decisions through schematics and oral presentations.
In-class test is to assess students' abilities of various aspects that can be measured through written test.
Laboratory work is to allow students to practice application of the theories and acquire a basic competence in system commissioning.
The end-of-semester examination assesses students' ability in solving real problems by applying their knowledge of psychrometry, air conditioning cycles, ventilation requirement and air conditioning systems.
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<tr><td>Student Study Effort Expected</td><td>
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<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures</td><td>22 Hrs.</td></tr>
<tr><td>▪ Tutorials</td><td>6 Hrs.</td></tr>
<tr><td>▪ Laboratory</td><td>6 Hrs.</td></tr>
<tr><td>▪ Mini design project presentation</td><td>3 Hrs.</td></tr>
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	▪ In-class test	2 Hrs.
	Other student study effort:	
	▪ Assigned reading	8 Hrs.
	▪ Preparing tutorial problems	20 Hrs.
	▪ Design project assignment	16 Hrs.
	▪ Preparing laboratory work	8 Hrs.
	▪ Test preparation	9 Hrs.
	▪ Examination preparation	20 Hrs.
	Total student study effort	120 Hrs.
Reading List and References	*Major references:* Chan KT. Study Guide: Air conditioning and ventilation, Dept. of BSE, PolyU, 2013. Jones WP, Air conditioning engineering, 5th ed. Oxford: Butterworth-Heinemann, 2001. (Chapters 2, 3, 5, 6, 7 and 17) McQuiston FC, Parker JD and Spitler JD. Heating, ventilating and air-conditioning analysis and design, 6th ed. New York: John Wiley & Sons, Inc., 2005. (Chapters 2, 3, 8 and 12) *Other references:* Wang SK. Handbook of air conditioning and refrigeration, 2nd ed. NY: McGraw-Hill, 2001. Haines RW and Hittle DC. Control systems for heating, ventilating and air conditioning, 6th ed. Boston: Kluwer Academic Publishers, 2003. ASHRAE Handbook 2013 Fundamentals. Atlanta: American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc., 2013.	