## Subject Description Form

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| Subject Code | **BSE4415** |
| Subject Title | **Building Energy Simulation** |
| Credit Value | 3 |
| Level | 4 |
| Pre-requisite<br><br>Co-requisite<br>Exclusion | AMA3301 or BSE3301 Numerical Methods and Computing, BSE3226 HVACR II, or equivalent.<br>Nil<br>Nil |
| Objectives | 1. To promote greater use of building energy simulation to underpin low energy building and HVAC system designs;<br><br>2. To deepen students' understanding about the fundamental engineering principles and numerical methods employed in building energy and building integrated renewable energy simulation;<br><br>3. To provide students with hands-on experience with performing building and system performance simulations; and<br><br>4. To impart to students useful computer programming techniques for efficient computing the energy performance of building energy and HVAC systems. |
| Intended Learning Outcomes | Upon completion of the subject, students will be able to:<br><br>a. Apply the fundamentals and methods employed in building energy simulation programs and thus to better harness and apply such tools;<br><br>b. Develop algorithms for evaluating the performance of a system;<br><br>c. Be able to develop computer programs as an evidence base tool for the energy analysis of building energy, renewable and HVAC systems.. |
| Subject Synopsis/ Indicative Syllabus | Building heat transfer modelling methods: Governing equations; analytical solutions using appropriate methods; simplified methods for modelling solar heat gain through fenestrations; Heat Balance Method for modelling space cooling load; theoretical basis of Radiant Time Series Method.<br><br>Plant and subsidiary systems modelling: Modelling performance of chillers, pumps, fans, cooling and dehumidifying coils.<br><br>Annual analysis of A/C system operation**:** operation methods for different thermal loads, outdoor air conditions and indoor air requirements; the annual analysis of operating the A/C systems with primary return air only, with primary and secondary return air, and with a heat recover for designing a proper A/C system and reducing energy uses in both cooling and reheating.<br><br>Computer programming and simulation workshops, and mini-project: Introduction to simulation and programming techniques, and their applications in simulating and modelling building energy systems; hands-on practices; simulation and programming assignments, and a mini-project in the energy analysis of building energy systems. |
| Teaching/Learning Methodology | The part on fundamentals will be covered by lectures, supplemented by tutorials;<br><br>Simulation and programming techniques will be introduced and demonstrated in Workshops with computing facilities;<br><br>An assignment and a mini-project will be employed to allow students to have hands-on practices and to develop knowledge and skills of computer programming, simulation and analysis. |

<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 (Please tick as appropriate)</td></tr>
<tr><td>a</td><td>b</td><td>c</td><td></td><td></td><td></td></tr>
<tr><td>Assignment</td><td>15</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>Mini-project</td><td>30</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td></td></tr>
<tr><td>End-of-semester examination</td><td>55</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:<br><br>
The assignments provide students with a chance to practice preparing inputs that can adequately describe the key characteristics of the building and system to be modelled and simulated, and to appreciate the impacts of using different methods on computing time and prediction accuracy.<br><br>
The mini-project will require the students to understand and apply the fundamentals in order that they can set up the governing equations and develop the solution algorithms for the processes they select to model and simulate.<br><br>
The examination is meant to provide a final feedback on the depth of understanding of students about the fundaments and appropriate modelling and simulation methods, and on their ability to formulate correct approach and method for solving system modelling and simulation problems.
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<tr><td>Student Study Effort Expected</td><td>
<table>
<tr><td>Class contact:</td><td></td></tr>
<tr><td>▪ Lectures</td><td>22 Hrs.</td></tr>
<tr><td>▪ Tutorial</td><td>5 Hrs</td></tr>
<tr><td>▪ Workshops</td><td>12 Hrs.</td></tr>
<tr><td>Other student study effort:</td><td></td></tr>
<tr><td>▪ Assignment & mini-project</td><td>42 Hrs.</td></tr>
<tr><td>▪ Self-studies</td><td>39 Hrs.</td></tr>
<tr><td>Total student study effort</td><td>120 Hrs.</td></tr>
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<tr><td>Reading List and References</td><td>
Clark JA. Energy Simulation in Building Design, 2nd Ed. Oxford: Butterworth-Heinemann, 2001.<br><br>
McQuiston FC, Parker JD, Spitler. Heating, Ventilating and Air Conditioning Analysis and Design, 6th Ed. New York: John Wiley & Sons, Inc., 2005.<br><br>
Underwood CP, Yik FWH. Modelling Methods for Energy in Buildings. Oxford: Blackwell Science, 2004.
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