MECH3423 Building Services Engineering II

http://www.hku.hk/bse/MECH3423/

Assignment 01 – Building Energy Simulation (Using MIT Design Advisor)

This assignment is intended to strengthen what you have learned during the lectures, by conducting hands-on exercises and developing practical experience with the calculations and analysis process. In order to develop the skills for building energy calculations, one computer software program has been selected for the learning process.

The MIT Design Advisor is a building simulation tool for estimating the heating, cooling, and lighting energy demand of an early-stage building design. It can be used to quickly compare and improve the performance of up to four different designs at the same time.

MIT Design Advisor : http://designadvisor.mit.edu/design/

Objective: To learn and appreciate the technique of building energy simulation using the online tool MIT Design Advisor

Procedure:

(a) Use a computer or suitable device to get access to the online tool.
(b) Develop a base case model using the input data as shown below.
(c) Study the input requirements and how to set up the model on MIT Design Advisor.
(d) Prepare three alternative designs as shown below to evaluate the building energy performance for three different scenarios.
(e) Examine the results and compare the performance of the three alternative designs.

Input Data (base case):

Location: Hong Kong

Occupancy and equipment: Office building, 9am-6pm, 0.1 people/m^2, lighting 500 lux, equipment 10 W/m^2

HVAC: Mechanical cooling & heating, indoor 24±1 ºC, RH 50%, fresh air 15 L/s/person, ~~air change rate = 2~~

Thermal mass: lightweight

Building geometry: Entire floor (4 facades + core) well-mixed air between zones, orientation N-S/E-W, 30 m x 30 m

Roof: bitumen roof

Room properties: 30 m (W) x 30 m (L) x 3.5 m (H), façade facing east, window 50% of exterior wall area, no shading devices, clear glass

Wall: commercial low insulation, R-value 3 m^2. K/W

Alternative Designs: (3 nos., by changing the base case settings; you may suggest your own alternative designs for the evaluation)

1. Ventilation system: Joint Natural Ventilation Cooling and Mechanical Heating
2. Lighting: 400 lux
3. Roof: Green roof

Evaluation of the Results

Students should analyse the energy simulation results and evaluate the performance of the alternative designs. Important issues to be considered and discussed include:

- Primary energy (heating, cooling and lighting loads) for yearly and monthly
- Thermal comfort in the room (predicted)
- Effect of natural ventilation (if any)
- Life cycle cost of energy and CO_2 emissions

Submission

Each student should prepare a technical report based on the data and information generated and learnt during the exercises. The report shall not exceed ten (10) A4 pages and should be submitted through the Moodle. The following guidelines on report writing may be useful.

Features of good reports (University of Reading)
http://me.hku.hk/bse/MEBS6023/A5_Reports_1.pdf
Structuring your report (University of Reading)
http://me.hku.hk/bse/MEBS6023/A5_Reports_2.pdf

References

ASHRAE, 2013. *ASHRAE Handbook Fundamentals 2013* , Chapter 19 - Energy Estimating and Modeling Methods, American Society of Heating, Refrigerating and Air-Conditioning Engineers Inc., Atlanta, GA. [ASHRAE Catalog: 697 A82 T4]

Kreider, J. F, (ed.), 2001. *Handbook of Heating, Ventilation, and Air Conditioning* , Chapter 6: HVAC Design Calculations, Section 6.2: Simulation and Modeling -- Building Energy Consumption, CRC Press, Boca Raton, Florida. [ebook via ENGnetBASE]

Thomas, P. C., 2002. Building energy performance simulation - a brief introduction, DES 17, In *BDP Environment Design Guide* , Royal Australian Institute of Architects, Red Hill, A.C.T., Australia. [AVS 720.47 E61 R8] [http://me.hku.hk/bse/MEBS6016/DES17.pdf]

Useful Web Sites

BEMBOOK (Building Energy Modeling Book of Knowledge)
http://www.bembook.ibpsa.us/
The MIT Design Advisor Frequently Asked Questions
http://designadvisor.mit.edu/design/faq
Understanding the Energy Modeling Process: Simulation Literacy 101 [BuildingGreen.com]
http://www.buildinggreen.com/features/mr/sim_lit_101.cfm