

# ME 491 THERMAL SYSTEMS DESIGN

## Midterm Exam

October 24, 2003 (Time: 2 hours)

This is an **open book** exam (text, notes and any other relevant material are allowed).

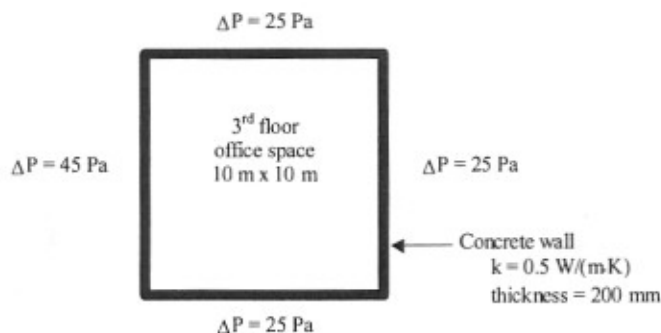
Answer **all 3 questions** and please note that psychrometric charts for sea level are attached.

State all **assumptions** and justify, where possible.

**Reference** all data used.

Marks

1. A building located in a cold climate is maintained at a temperature of 22°C with 1 kg/s of supply air at 35°C. The only latent load in the building is due to 120 people generating an average of 45 g/h each. **(a)** What must the relative humidity of the supply air be if the indoor humidity is to be maintained at 30% RH? **(b)** What is the sensible heat load of the building? (10)
2. A building owner has decided to use an economizer cycle to cool a building that has a sensible cooling load of 1.5 kW and a latent cooling load of 0.5 kW. The owner has decided that the indoor temperature can vary between 22°C and 26°C and the indoor humidity can vary between 40% RH and 70% RH. **(a)** During which of the following outdoor conditions will you be able to use outdoor air only to condition the building to the specified conditions (i.e., no heating or cooling): (i) 22°C and 90% RH, (ii) 22°C and 70% RH and (iii) 22°C and 40% RH? **(b)** If the outdoor conditions were (15°C and 60% RH), what is the minimum mass flow rate of outdoor air that must be supplied to the building to satisfy the specified indoor conditions? (10)
3. You are designing a heating and ventilation system for a 10-m square office building (10 stories and a total height of 35 m) in Vancouver, BC. Each wall on each floor has 5 double-pane, vinyl windows that are 2 m high by 1 m wide. The fixed windows have a 6.4 mm air space with no low-e coatings and are new, tight-fitting windows. The exterior walls are 200 mm thick and are made of a lightweight composite concrete containing polystyrene beads. The thermal conductivity of the composite concrete is 0.5 W/(m·K). Determine the required capacity of the heating system to heat the 3<sup>rd</sup> floor of this office building, given that the exterior pressure is 45 Pa higher on the windward wall and 25 Pa higher on the other walls compared to the interior pressure. (20)



**TOTAL (40)**