University of Hong Kong
MEBS6008 Environmental Services II
2007-2008 Examples/ Revision Exercise

Remark: Suggested Solution available for downloading on 18 April 2008 evening (Note: The suggested solution may not be all correct)

Question 1

Load Profile

Church operates for 3 hours on Sunday morning. Load steady for each hour.
Instantaneous peak hour load of 40 ton. Chiller capacity at 40 ton if no storage.
The integrated cycle of cooling load is 40 Tons x 3 = 120 ton-hours.

Day Cycle with Partial Storage

Plant operates 24 hours => Chiller Capacity is ? tons
Storage capacity is ? ton-hours
If plant cost is $4,800/ton => the saving is $?.
If storage cost is $560/ton hour=> storage is $?
Cost saving = $?.

Day Cycle with Full Storage - 3 hour load period was the on-peak period

Plant operates 21 hours => Chiller Capacity is ? tons
Storage capacity is ? ton-hours
Storage requirement increases by ? tons
As plant cost is $4,800/ton and storage cost is $560/ton-hour
Increase in storage capacity comparing with partial storage is ? tons
The increase in plant capacity comparing with partial storage is ? ton
Total increase in cost in comparison with partial storage = $?.

Church Example -Weekly cycle- Partial storage plant

Operates for 168 hours at ? ton
Storage capacity = ? ton-hours

Church Example -Weekly cycle- Full storage plant

The plant Capacity = ? ton
Storage = ? ton-hours

University of Hong Kong
MEBS6008 Environmental Services II
2007-2008 Examples/ Revision Exercise

Question 2

As a building services consultant, you are asked by your client to design an air-conditioning system for a building situated in Kwun Tong.

Your client asks on the possible saving due to the use of an ice storage system in comparison with conventional system that you have to work out.

The daily cooling load is as follows (26 days per month): -

Time	*kW cooling*	*Time*	*kW cooling*
9	*2800*	*21*	*140*
10	*2900*	*22*	*140*
11	*3100*	*23*	*140*
12	*2900*	*24*	*0*
13	*4000*	*1*	*0*
14	*3600*	*2*	*0*
15	*3500*	*3*	*0*
16	*2800*	*4*	*0*
17	*3700*	*5*	*0*
18	*2900*	*6*	*140*
19	*2500*	*7*	*140*
20	*2400*	*8*	*140*

Conventional System (assume bulk tariff)

Two chillers with each cooling capacity at 2000kW

The $kW_{cooling}$ per $kW_{electrical}$ of the chiller is 3.5

On peak electrical demand: Maximum Demand is 1344kVA.

Off peak electrical demand: Maximum Demand is 47kVA

Ice Storage System (ice storage tariff)

One 2000kW ice storage chiller and one 2100kW normal chiller

The monthly operating cost for ice pump is approximately $20,238.

The $kW_{cooling}$ per $kW_{electrical}$ of the chiller is 3.5

The $kW_{cooling}$ per $kW_{electrical}$ of the ice storage chiller is 2.8.

On peak electrical demand: Maximum Demand is 710kVA.

Off peak electrical demand: Maximum Demand is 840kVA

(Ignore both fuel clause charge and 2008 special rebate in your calculation)

University of Hong Kong
MEBS6008 Environmental Services II
2007-2008 Examples/ Revision Exercise

Question 3

A ground sourced water heat pump employing a plate-frame exchanger would be employed in a building in Toronto. It is found that the average ground temperature of Toronto is about 10^oC. You may assumed that this is also the ground water temperature year round, for the ground water in use will be from a depth where annual fluctuations in temperature are small.

The total cooling load of this building is 372kW while the total heating load is 131kW.

The temperature difference between the entering temperature of water to heat exchanger (water loop side) and leaving temperature of the heat exchanger (ground water side) is 2.8^oC.

*The following information on the **water loop** of the heat pump is as follows:*
The water leaving the exchanger is at 29.4^oC in summer and 4.4^oC in winter.
Propylene glycol, which is an anti-freeze, is added in the water loop (correction factor 0.94)
Flow rate is 9.5 litre/second

Determine the specified flow rate of ground water of this plate-frame exchanger in the tender specification.

Question 4

A hygroscopic rotary heat wheel (3.5 m diameter and 250 mm deep wheel) has a 85% void volume and is operating at 14 rpm. Exhaust air at 4.5 m^3/s, 23°C dry bulb, 16°C wet bulb and 1.2 kg/m^3 air density is used to pre-cool supply outdoor air at 3.5m^3/s, 36°C dry bulb, 27°C wet bulb and 1.15 kg/m^3 air density. The sensible effectiveness ratio is 65% and total effectiveness ratio is 52%.

Calculate

i) Theoretical maximum total, sensible and latent heat transfer;
ii) Sensible, latent and total heat recovered;
iii) Supply air dry bulb temperature, wet bulb temperature and enthalpy after leaving the heat wheel

University of Hong Kong
MEBS6008 Environmental Services II
2007-2008 Examples/ Revision Exercise

Question 5

Suppose a chilled water pump operating at 564rpm is fixed on a concrete base (combine mass of pump and concrete base is at 500kg) which is supported by 4 spring vibration isolators having static deflection of 25mm. It is given that the driving force of the pump is 4800N.

Calculate

i) The natural frequencies of the vibration isolators (i.e. spring);

ii) The stiffness (i.e. k) of the vibration isolators (i.e. spring);

iii) The transmissibility;

iv) The displacements of the spring.

Question 6

You are given the noise levels at various frequencies which are as follows:-

Centre Frequency(Hz)	*63*	*125*	*250*	*500*	*1000*	*2000*	*4000*	*8000*
Actual Pressure Level (dB)	*63*	*52*	*45*	*38*	*31*	*24*	*16*	*10*

Determine the overall A-weighted sound pressure level.

Suppose there is another overall A-weighted sound pressure level at 44dBA. Determine the combined A-weighted sound pressure level.

Question 7

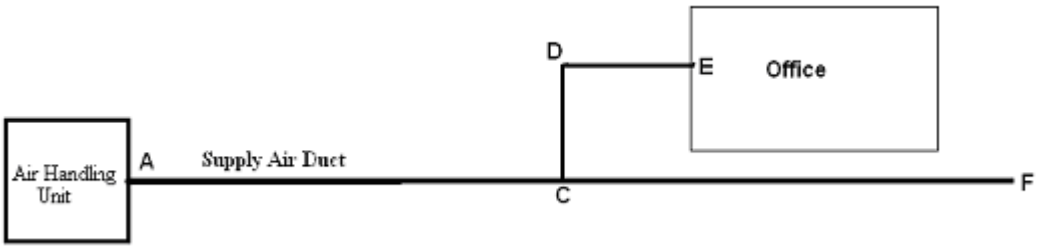
The reverberant sound pressure level in a room due to noise of a refrigeration compressor (its sound power level at 8kHz is 75dB) in the same room is to be reduced by providing an acoustic enclosure. Internal surface area of the rectangular enclosure walls and roof is 54m^2. The surface area of compressor is 26m^2. The floor area (not covered by machine) is 6m^2.The absorption coefficient of the compressor, the floor and acoustic enclosure are respectively 0.03, 0.03 and 0.8 respectively.

Determine the sound reduction index necessary for the enclosure walls and roof at 8kHz if the reverberant sound pressure level of the room is not to exceed NC40.

University of Hong Kong
MEBS6008 Environmental Services II
2007-2008 Examples/ Revision Exercise

Question 8

In a ventilation system comprising duct, duct elbow, duct take-off (branch) an etc as shown below are supplying conditioned air from the air handling unit to the office. Details are as follows:-



Duct section AC	*:*	*800 mm x 600 mm x 10 m*
Duct section CD	*:*	*600 mm x 450 mm x 4 m*
Duct section DE	*:*	*600 mm x 450 mm x 3 m*
Duct section CF	*:*	*600 mm x 600 mm x 12 m*

You are requested to

1) Determine the noise attention at 63Hz due to the duct section AC.
2) Determine the noise attention at 125Hz due to the take-off at C.
3) Compare the noise attention at 125Hz and 250Hz due to elbow D.
4) Compare the noise attention at 63Hz and 250Hz due to end reflection at E.