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التسلسل: 48

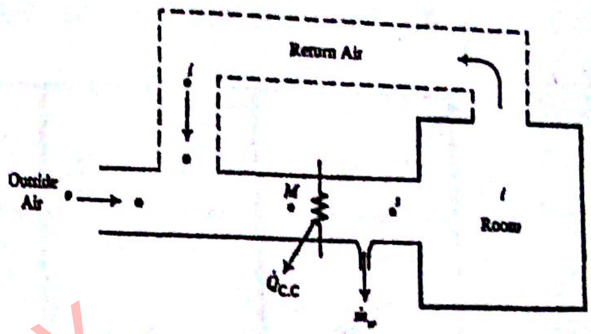
Q1) [10 points] The calculated sensible and total loads for a given space are 12 kW and 13.45 kW respectively.

- The inside design conditions are 25 °C dry bulb and 40% relative humidity.
- The dry bulb temperature of the supply air is 11 °C .
- The outside air is at 34 °C dry bulb and 30% relative humidity.

Consider three scenarios in which the percentage of the fresh air to the supply air is increased from 0% to 50 % and finally to 100%.

Evaluate the following:

1. Sketch the process (indicate all points i, o, r, M and S) on the psychrometric chart attached.
2. Calculate the supply air mass flow rate in kg/s.
3. Calculate the supply air enthalpy and humidity ratio.
4. Evaluate the capacity of the cooling coil and the flow rate of condensed water in each of the three cases.
5. (For the first case only "0% fresh air") what would be the the flow rate of the chilled water coming from the chiller at 7 °C and leaving the cooling coil at 12 °C?



Mass flow rate of supply air (kg/s)					
	Outside air	Supply air	(I)Mixed air 0% fresh air	(II) Mixed air 50% fresh air	(III)Mixed air 100% fresh air
Moisture content kg/kg dry air	0.011	0.0085	0.0088	0.00965	0.011
Specific enthalpy kJ/kg dry air	62	33	47	54.5	62
Cooling coil capacity (kW)			12 kW	~~15.5~~ 18.5	~~19.9~~ 24.9
Mass flow rate of condensed water (kg/h)			0	~~0.0235~~ 0.00116	~~0.0035~~ 0.0023
Mass flow rate of chilled water kg/s)	0.5				

9

Question 2 [6 points]

A classroom is maintained at 20 °C dry bulb and 45% RH, and is occupied by fifty students. Calculate the following:

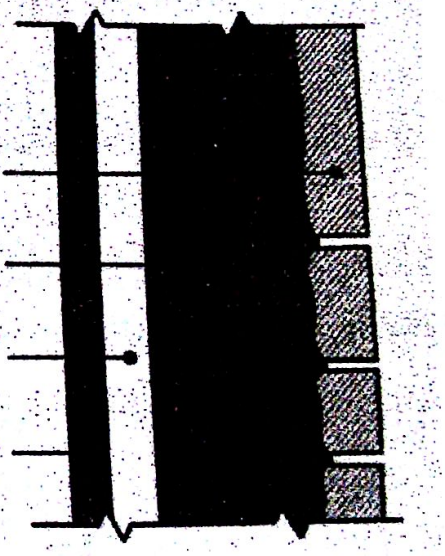
a. Total heat gain rate due to occupants if (CLF)occ.=0.58
b. Total and latent heating loads due to ventialtion if the outside fresh air is available at 5 °C dry bulb temperature and 60% RH.

Question 3 [7 points]

A room having the follwing dimensions: lengh 10 m, width 8 m, and height 3m. The inside and outside design temperatures are 21 °C and 2 °C respectively. The construction of the wall is shown below, if the inside air relative humidty is 80%, determine

1. The inner wall surface temperature at which moisture will start to condense.
2. the minimum thickness of the insulation material that will ensure no moisture will condense on the inner wall surface.
3. The heat loss from the walls of this room.

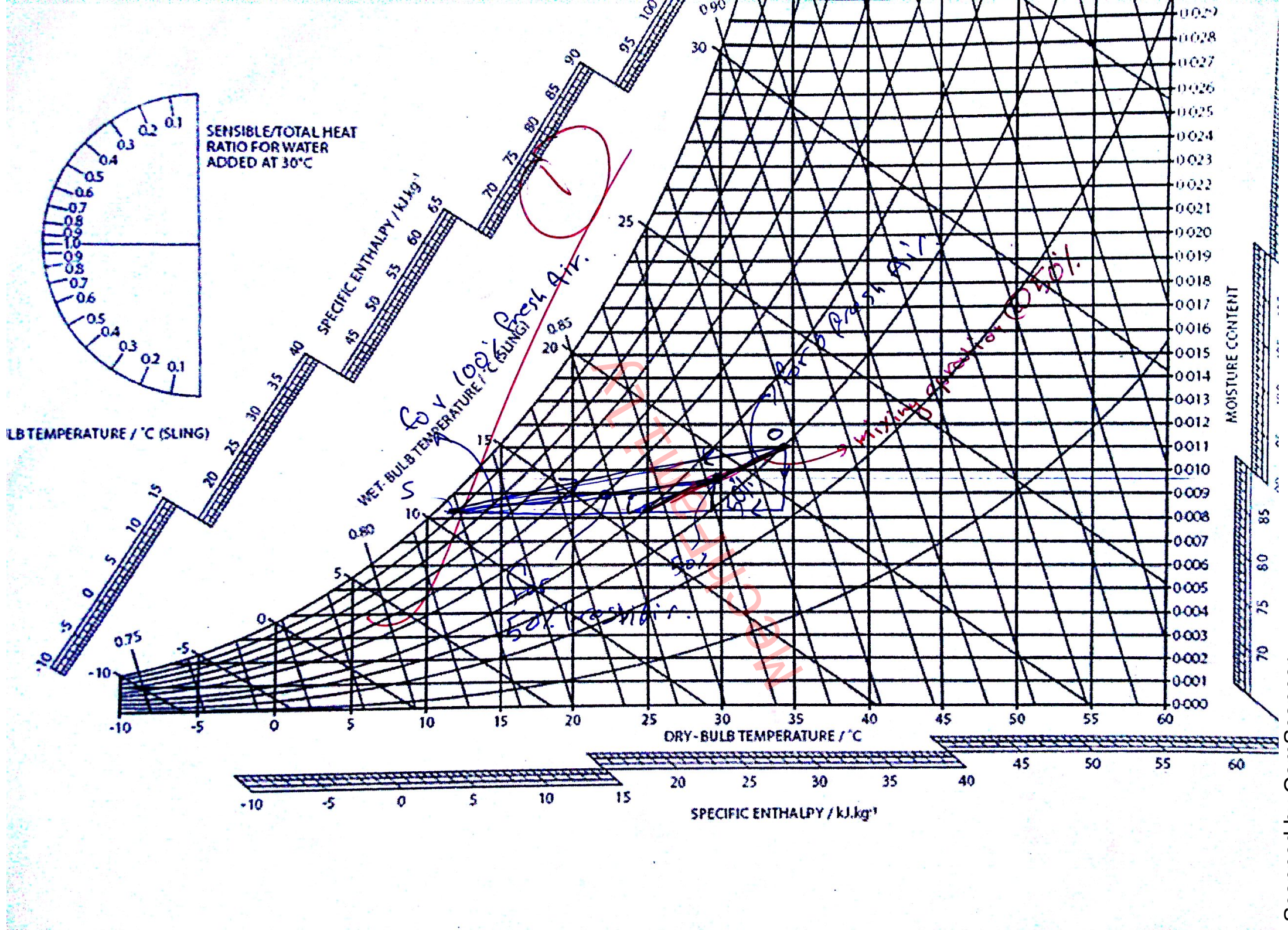
k W/m°C	Thickness	Layer
1.70	0.07 m	① Stone
1.75	0.20 m	② Concrete
0.04	m	③ Insulation
1.20	0.03 m	④ Plaster



Question 4 [7 points]

A Jordanian family consumes 100 liters of D.H.W at 60 °C per day, consider that the C.W from the mains is at 10 °C, calculate:

1. The monthly thermal energy required to heat the D.H.W in kJ.
2. If this family utilized a diesel boiler (efficiency 80%, C.V for diesel is 40000kJ/kg, density 850 kg/m3, cost .6 JD/liter) what would be the monthly cost of heating the D.H.W.
3. If this family utilized an electric heater with an efficiency fo 90%, and considering the cost of electricity to be 0.1 JD/kWh, what would be the monthly cost of heating the D.H.W.



9.5

Q1)

$Q_s = 12kW$ $Q_{tot} = 13.45$

$h_i = 47$ $T_{in} = 25$ $\Phi = 40\%$ $T_{sup} = 11\,C^\circ$ $\Phi_{sup} = 92\%$

$h_o = 62$ $T_{out} = 34C^\circ$ $\Phi = 30\%$ $h_{su} = 33\ kJ/kg$

$W_{out} = 0.011$

~~① Of Supply Air from Air~~

~~$\dot{m}_{sup} = 0$~~

① $12 = \dot{m}(1)(25-11)$

$\Rightarrow \dot{m} = 0.86\ kg/s$.

Supply Air

② $T = 11C^\circ$ $W_{sup} = W_{inside} = 0.0083$

$\Rightarrow \Phi = 92\%$ $h = 33kJ/kg$. ✓

③

Ⓘ For 0% Fresh Air.

$Q = 0.86(1)(25-11) = 12\ kW$ → $Q_{tot} = ?$

$\dot{m} =$ Zero the same W.

Ⓘ For 50% Fresh Air.

$\frac{0.86}{2}(47) + \frac{0.86}{2}(62) = 0.86(h) \Rightarrow h = 54.5\ kJ/kg$.

$\frac{0.86}{2}(0.0083) + \frac{0.86}{2}(0.011) = 0.86(W) \Rightarrow W = 0.009765\ kg/kg\ DA$

$T = 29C^\circ$

$Q = 0.86(1)(29-11) = 15.5\ kW$.

~~$\dot{m}_{air} = Q_{tot} = 0.86(54.5-33) = 18.5$~~

$Q_{lat} = 3$

~~$3 = \dot{m}_a(125.7)$ → $\dot{m}_a = 0.0238$~~

$\dot{m}_w = 0.86(0.009765 - 0.0083) = 0.00116\ kg/s$

⟸ Cont

Q1 Cont.

(III) For 100% Press.

$Q_{tot} = 0.86(62-33) = 24.9$

$Q_{sen} = 0.85(34-11) = 19.78$

$Q_{lat} = 5.12 = \dot{m}_w(2546.6) \Rightarrow \dot{m}_w = 0.00235\ kg.$

$\dot{m}_w = 0.86(0.011 - 0.0083) = 0.00232\ kg/s.$

(5)

$12 = \dot{m}(4.18)(12-7)$

$\Rightarrow \dot{m} = 0.5\ kg/s.$

(Q2) $T_i = 20$ $h_i = 34$ $\Phi_i = 45\%$ 50 ft.

(1) $Q = 50\left((70)(0.58) + 45\right) = 4280\ W$

$T_o = 5$ $\Phi_o 60\%$ $h_o = 13$

$v_o = 0.79$

(2)

$\dot{V} = 8 \times 50 = 400\ L/s = \frac{0.4\ m^3/s.}{0.79\ kg/m^3}$

$\dot{m} = 0.5\ kg/s.$

$Q_{tot} = 0.5(1)(34 - 13) =$ 10.5 kW.

$Q_{sen} = 0.5(20-5) = 7.5\ kW$

$Q_{lat} = - 7.5 =$ 3 kW.

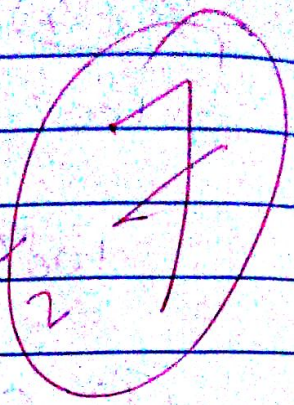
Q3

3) $10 \times 8 \times \frac{h}{3}$

$T_i = 21\,C \qquad T_o = 2C°$

$\phi_i = 80\%$

① T_{dp} @ 21 & 80% = **17 C°**



② $U_{inside} = \frac{1}{0.12} = 8.33$

$A_{wall} = 2(10+8)\times 3 = 108\ m^2$

$Q = 8.33\,(108)\,(21-17) = 3598.5\ W$

$$U_{overall} = \frac{1}{\underbrace{0.12}_{R_{out}} + \frac{0.06}{J} + \frac{0.07}{1.7} + \frac{0.2}{1.75} + \frac{0.03}{1.2} + \frac{x}{0.04}}$$

$Q = U$

$3598.5 = U\,108\,(21-2) \Rightarrow$ **$U = 1.75\ W/m^2K$**

$$1.75 = \frac{1}{0.36 + \frac{x}{0.04}}$$

$\Rightarrow$ **$x = 0.0085\ m$**

③ $Q_{loss} = 1.75\,(108)\,(21-17) = 3598\,W$

$= 3.598\,kW$

Q4

100L @ 60c°

@ 10c°

100L = 100 kg.

① $Q = 100(4.18)(60-10) = 20900$ kJ

② $\eta = 80\%$ 40 MJ/kg

$\rho = 850 kg/m^3$ 0.6 JD/lit

$$M_{fuel/day} = \frac{20900}{(40000)(0.8)} = 0.65$$

$M_{month} = 0.65 \times 30 = 19.5$ kg/mole

$\frac{19.5}{850} = 0.023\ m^3 \times 1000 = 23$ L

Cost = $23 \times 0.6 =$ 13.8 JD/month.

③ $\frac{20900}{0.9} = \frac{23222}{3600}$ kJ = 6.45 kWh/day

$6.45 \times 30 = 193.5$ kWh/month.

@ $193.5 \times 0.1 =$ 19.35 JD/month