



Close book exam. Answer all questions. Draw schematic diagram whenever applicable, and clearly state your assumptions. Air conditioning tables and are permitted

يسمح للطالب باستخدام جداول التكييف الهواء

Name: _____

Question (1) (16 marks)

- (a)- A 12*6 m gym hall (in a middle floor building) is to be conditioned. Space height is 6m. The hall has no windows. All walls are internal walls (partitions) and 6m side wall facing north has the entrance door of the hall. All walls are constructed of 200mm concrete block. Ceiling has mass inside insulation with suspended ceiling and R-value = 2.5 m²k/W. The hall could be occupied by 100 persons. Lighting is 25 W/m² and no equipment. Indoor air is at 24°C and 50% R.H and outdoor air is assumed to be 38°C and 45% R.H. Calculate the space total cooling load. Assume ventilation rate of 2.5 L/s per person and base your calculations on 21 August, 16:00 O'clock and 32° north latitude. Also, assume that all neighbours spaces through walls and ceiling are not conditioned space.
- (b)- Compute the total heat gain for south windows of an office building that has no external shading. The windows are double-glazing with a 6.4 mm air space and with regular plate glass inside and out (U=3.94 W/m². °C). Draperies with shading coefficient of 0.7 are fully closed. Make the calculation for 12 noon at 30° south latitude in: (a)- August (b)- December
Assume the following: - Total window area is 40 m²
- Outdoor conditions are 37 °C d.b.t and 4 °C w.b.t
 - Indoor design conditions of 25 °C d.b.t and 20 °C w.b.t
 - Total office area is 45 m²

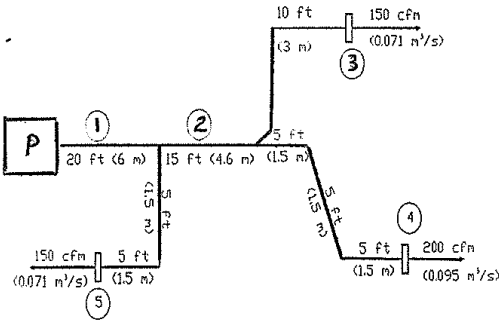
Question (2) (15 marks)

- A)- In the air washer, the mean surface temperature of the water droplets has a great influence on the state of the outlet air condition. On a psychrometric chart, sketch and name all possible thermodynamic processes that may occur at different mean surface water droplets temperatures?
- B)- Cooling water leaves the water-cooled condenser of a power plant and enters a wet cooling tower at 35 °C at a rate of 100 kg/s. the water is cooled to 22 °C in the cooling tower by air which enters the tower at 1 atmosphere, 20 °C, 60 percent relative humidity and leaves saturated at 30 °C. Determine:
- (a)- The volume flow rate of air into the cooling tower, and
 - (b)- The mass flow rate of the required makeup water

Question (3) (15 marks)

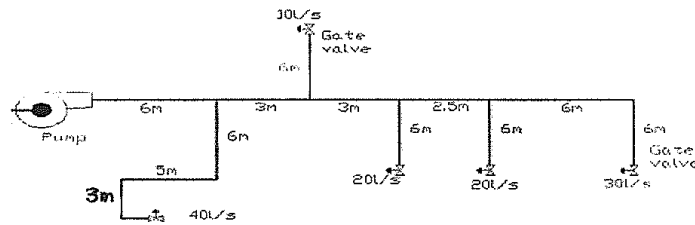
- (a) List the main advantages of using waste energy recovery in air conditioning systems? Sketch three types of heat recovery air conditioning systems?

- (b) The following figure shows a typical duct layout. Design the duct system. Take the velocity of air in the main duct as 8 m/s. Compute also, the total pressure loss. (assume that, the equivalent length for each fitting losses is 0.6 m and the total pressure drop through coil and filters are 0.53 Pa).



Question (4) (14 marks)

- A)- List the main advantages and disadvantages of using all water system air conditioning systems?
 B)-In the piping system shown schematically, size the pipes and calculate the total pressure loss (assume that, the equivalent length for each fitting losses, gate valve and check valve is 0.6 m, 0.3 m and 6.5 m respectively)



Question (5) (15 marks)

- A)- Define the following: humidity ratio, relative humidity, and coil By-pass factor?
 B)- A space is air conditioned in winter. The air conditioning plant comprises a preheating coil, an air washer and a reheating coil. The rates of sensible and latent heat losses from the space are 232.6 and 58.939 kW, respectively. The space is maintained at 21°C d.b.t and 14°C w.b.t. Air is supplied to the space at 38°C. Outdoor air is saturated at 5°C. The mass flow rate of ventilation air is 50% of that to the space. The air washer has an efficiency of 50%. Draw a schematic flow diagram of the air conditioning system, plot the cycle on the psychrometric chart, then determine:
 a) The flow rate of the conditioned air to the space in m³/s.
 b) The spray-water temperature.
 c) Rate of addition of makeup water to the sump of the washer in kg/s.
 d) Rate of heat addition to the air in each of the heaters in kW

All the best

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