UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION

(ONLINE)

SEMESTER I

SESSION 2020/2021

COURSE NAME	:	AIR CONDITIONING SYSTEM DESIGN
COURSE CODE	:	BDE40103
PROGRAMME	:	BDD
EXAMINATION DATE	:	JANUARY / FEBRUARY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	**PART A**: ANSWER **FOUR (4)** QUESTIONS **ONLY** FROM **FIVE (5)** QUESTIONS. **PART B**: ANSWER **ALL** QUESTIONS.

THIS QUESTION PAPER CONSISTS OF NINE (9) PAGES

PART A

Q1 (a) The chemical requirements of refrigerants pertain to flammability, toxicity, reaction with water, oil and construction materials and damage to refrigerated products Describes abouts flammability, toxicity, and reaction with water

(4 marks)

(b) A window air conditioner is a small air conditioner designed to be placed within the boundaries of a window frame. Explain the principle of window type room air conditioner base on schematic diagram of a window type air conditioner as shown in **Figure Q1(b).**

(8 marks)

(c) A Carnot refrigerator has working temperatures of 32°C and 70°C as shown in **Figure Q1(c)**. If it operates with R 134a as a working substance, using table of properties of R 134a, calculate the work of isentropic compression and that of isentropic expansion, and refrigerating effect, heat rejected per kg of the refrigerant, and COP of the cycle.

(8 marks)

Q2 (a) The Room comfort condition in Malaysian Standard MS1525:2014 are to dependent on various factors including air temperature, mean radiant temperature, humidity, clothing insulation, metabolic rate and air movement preference of the occupant. Explain details about room comfort condition should consider the following three main factors:

i. Dry bulb temperature;
ii. Relative humidity; and
iii. Air movement (air velocity).

(10 marks)

(b) Calculate the Predicted mean vote (PMV) and Predicted percent dissatisfied (PPD), if:

i. Metabolic level, M= 60 W/m^2

ii. Clothing insulation, I_{cl}, = 0.1 m^2 kW

iii. Air temperature, t_a, – 25 °C

iv. Mean radiant temperature, t_r, = 20 °C

v. Relative air velocity, v_{ar}, – 0.1 m/s

vi. Water vapour partial pressure, pa, – 1500 Pa.

vii. The effective mechanical power, W = 0 W/m^2

viii The clothing surface area factor, f_{cl} = 1.1145

ix. Convection heat transfer coefficient, h_c = 2.08

x. The clothing surface temperature, t_{cl} – 34.7 (°C).

xi. Plot PMV and PPD on **Figure Q2(b)** and justify the thermal comfort.

(10 marks)

Q3 (a) A psychrometric chart is a graphical representation of the psychrometric processes of air and commonly used in solving HVAC problems. Explains seven (7) physical properties in psychometric chart.

(7 marks)

(b) A mixture of dry air and water vapour is at a temperature of 21°C under a total pressure of 736 mm Hg. Find:

i. Partial pressure of water vapour,

ii. Relative humidity,

iii. Specific humidity;

iv. Specific enthalpy of water vapour (using Thermodynamic properties of water);

v Enthalpy of air per kg of dry air; and

vi. Specific volume of air per kg of dry air.

(13 marks)

Q4 (a) The heat gain components that contribute to the room cooling load as shown **Figure Q4 (a)**. Explains detail about A_1 until A_6.

(6 Marks)

(b) A room has 130 ft^2 of single glass windows with vinyl frame. Inside air temperature is 70°F and outdoor average temperature is on a design day is 90°F. Find cooling load due to conduction heat gain through the windows at 2 PM Daylight saving time with cooling load temperature different 12°F, correction for latitude and month is 1 and overall heat transfer coefficient (U) for glass is 0.9 BTU/hr-ft^2-°F.

(7 marks)

(c) The heat gain for heavy work factory at night is 84,000 Btu/hr and the temperature at 75°F DB. Assume that, how many peoples in the factory, if air conditioning system are not shut down with 4 hours operation in space and 8 hours after each entry into space.

(7 marks)

Q5 (a) The duct show in **Figure 5(a)** has 7000 CFM flowing through it. The fiction loss from point 1 to 2 is 0.43 in.w.g. If the static pressure at 1 is 1.23 in w.g., determine the static pressure at 2?

(6 marks)

(b) The pump included in the pipe network shown in **Figure 5(b)(1)** has an impeller diameter of 180 mm and the performance curves of the pump for three different speeds are depicted in **Figure 5(b)(2)**. If the pump is operated at 2000 rpm, calculate the total water flow rate, the head, and the ideal power input to the pump when (i) the valve is fully open, and (ii) when the valve is partially closed.

(14 marks)

PART B

Q6 (a) The noise problem associated with fans may cause noise disturbance to nearby residents (see **Figure Q6(a)**). It mainly comes from the interaction of flow turbulence and solid surface of fan blades, and blade / fan vibration. The noise is transmitted upstream and downstream in the connecting ducts or to the atmosphere through the fan case. Give two practical remedies to solve this problem. Illustrate the systems with the appropriate figures.

(10 marks)

(b) Two equipment (a chiller and a fan) having cooling capacity 100 ton and 20 hp fan respectively are installed outdoors. The most affected noise sensitive receiver is identified to be a residential flat which is at 30m and 20m away from the fan and the chiller, and Tonality Correction is 6 dB respectively. Determine the sound pressure level (SPL) at the residential flat contributed by the two equipment using **Table Q6(b)**.

(10 marks)

END OF QUESTION

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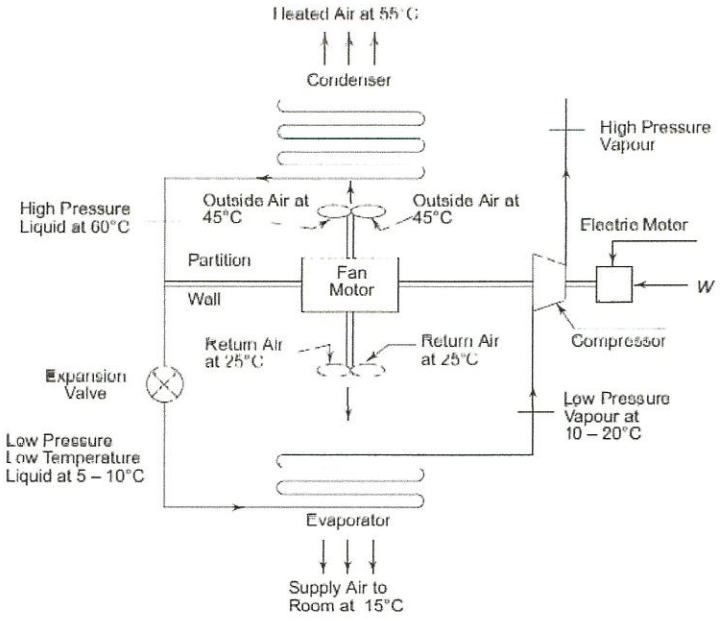

Figure Q1(b): Schematic diagram of a Window air

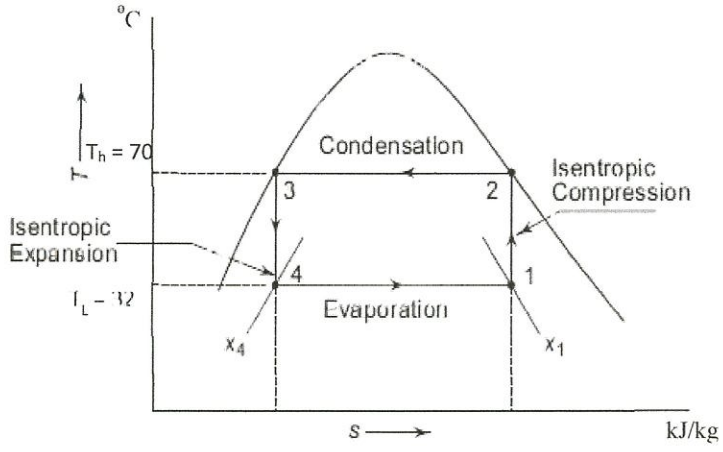

Figure Q1 (c): Reversed Carnot cycle with vapour as a refrigerant

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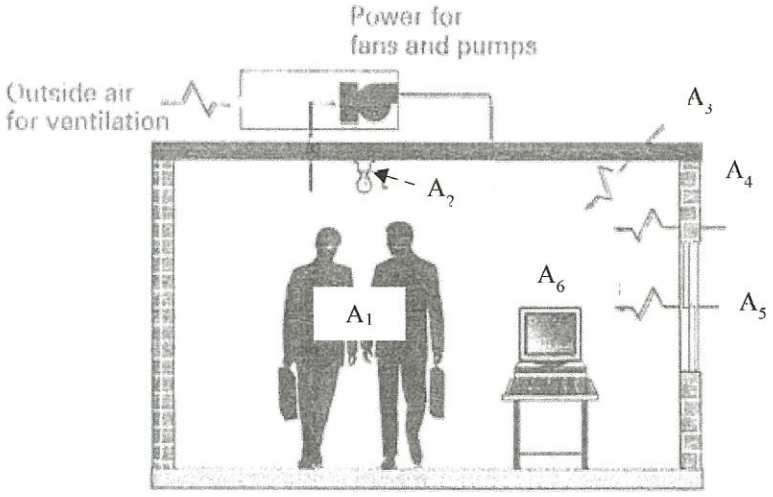

Figure Q4 (a): Room heat gain component,Q

Given:

1 in w = 69.6 ft air

Gravity, g = 32.2 ft /sec²

$$\frac{1\ in.w}{69.6\ ft.air}$$

/000 CFM

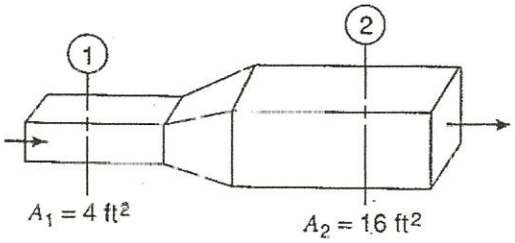

Figure Q5 (a).Air Flow in the Ducting

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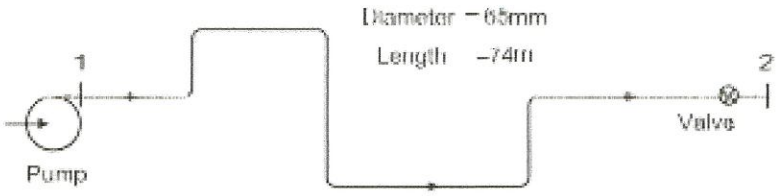

Figure Q5 (b)(1):Air Flow in the Ducting

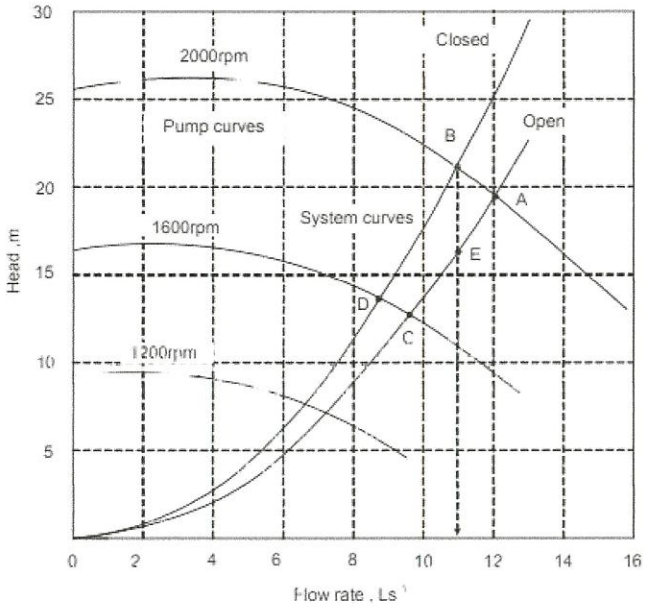

Figure Q5 (b)(2):Pump and system characteristics

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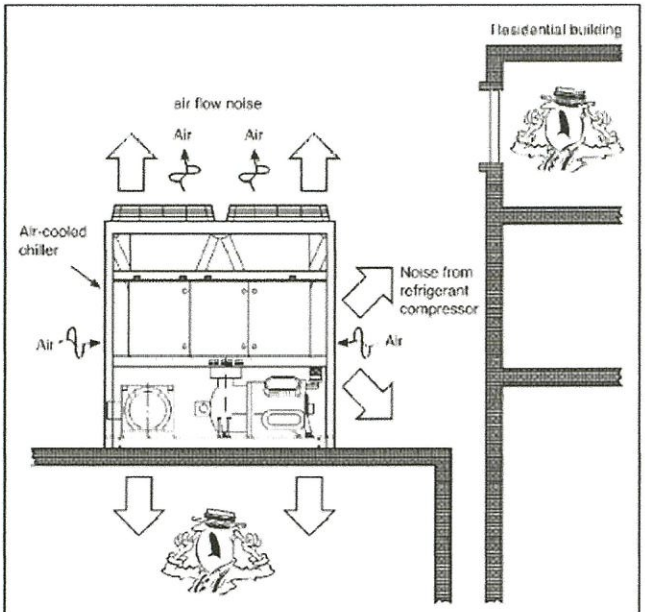

Figure 6 (a): Air-borne Noise from Air-cooled Chillers

Table Q 6 (b): Estimate for Sound Pressure Level

NSR	Noise Sources	SWL (dB(A))	Distance (m)	Distance Attenuation (dB(A))	Noise Level (dB(A))
Residential Flat	Chiller				
	Fan				
Summed Noise Level (dB(A))					
Correction for Acoustic Reflection (dB(A))					
Noise Level at Noise Sensitive Receiver (NSR), (dB(A))					
Acceptable Noise Levels (ANL)					
Noise Exceedance					