CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2014 SESSION

SUBJECT CODE	:	FRD 30103
SUBJECT TITLE	:	SELECTION AND INSTALLATION OF RAC COMPONENTS
LEVEL	:	DIPLOMA
TIME / DURATION	:	9.00 am - 11.30 am (2.5 HOURS)
DATE	:	05 JUN 2014

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists of TWO (2) sections. Section A and B. Answer ALL question in section A. For section B, answer TWO (2) questions only.
6. Answer all questions in English.

THERE ARE 7 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (60 MARKS)

INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

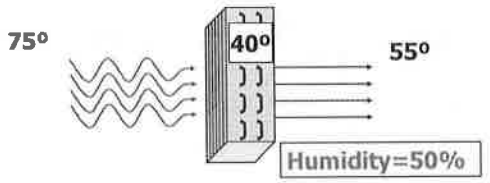

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Figure Q1: Typical A/C Evaporator (Temperature °F)

(a) Referring to Figure Q1, answer the following questions:

(i) Find the temperature difference, TD.

(4 marks)

(ii) Find ΔT.

(4 marks)

(iii) What happen to the humidity if we lower the TD.

(2 marks)

(b) List five (5) characteristics of a cooling coil.

(5 marks)

Question 2

Answer the following questions:

(a) List three (3) steps to do a selection of an air conditioner unit for home use. Give an effect which will occur when the air conditioner unit chosen is under size and over size.

(8 marks)

(b) Explain the importance of the sub cooling due to pressure drop and heat addition in the pipe line of the refrigeration system. Give an example and sketching is required.

(7 marks)

Question 3

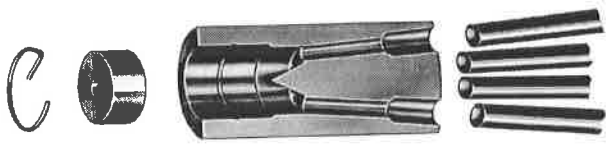


Figure Q3: A cross sectional drawing of a distributor.

(a) An example of a distributor as shown in figure Q3. Draw a distributor on an evaporator. Your sketch drawing must be based on the evaporator coil characteristic which has 4 rows, 4 circuits and 4 inlets and outlets. (Sketching and labeling for every part are required).

(10 marks)

(b) Give two (2) functions of the distributor on the evaporator.

(3 marks)

(c) Describe how you improve the flow of refrigerant in the distributor.

(2 marks)

Question 4

Given is a design condition for standard air conditioning system. Room temperature is 24°C, evaporating temperature 5°C, ambient temperature 35°C and condensing temperature 52°C. The compressor is rated at a 40°F (69 psig) suction and 125°F (280 psig) condensing. Calculate:

(a) The condenser split.

(2 marks)

(b) Compression ratio.

(3 marks)

(c) Let say you are attending to a customer complaint about the air conditioner. Explain the procedures to replace a compressor.

(10 marks)

SECTION B (40 MARKS)

INSTRUCTION: Answer only TWO questions
Please use the answer booklet provided.

Question 5

Refering to figure Q5a and Q5b. Select a unit that uses R12 and is required to have a duty of 13000 Btu/h when evaporating at 20°F with a ΔT1 of 13°F. Answer the following:

(a) Find the correction factor.

(5 marks)

(b) Calculate total cooling capacity.

(10 marks)

(c) Select a suitable model of cooler.

(5 marks)

Double discharge ceiling mounted coolers

Table 2.6 Capacities for double discharge ceiling mounted coolers, evaporating temperature 32°F/0°C, 6 fins/inch (Searle)

Refrigerant	ΔT_1		Model 45	65	85	120	180	240
R12	15°F	Btu/h	4878	8648	12 006	17 504	21 950	27 038
	8°C	kcal/h	1167	2070	2873	4 189	5253	6 470
	8°C	watts	1359	2407	3342	4872	6110	7 526
R22	15°F	Btu/h	5171	9167	12 726	18 554	23 267	28 660
	6°C	kcal/h	1237	2194	3 046	4 441	5568	6 859
	8°C	watts	1439	2552	3 543	5 165	6 477	7 977
R502	15°F	Btu/h	5024	8907	12 364	18 029	22 609	27 849
	8°C	kcal/h	1202	2132	2 960	4 315	5 411	6 665
	8°C	watts	1399	2479	3 442	5 019	6 293	7 752

For other temperature differences and evaporating temperatures, multiply the basic rating by the relevant capacity correction factor shown in the following tables.
These figures have been obtained from the difference between air on temperature and refrigerant evaporating temperature, i.e. ΔT_1.
The data was obtained without the use of suction liquid heat interchangers.

Figure Q5a: Double discharge ceiling mounted coolers

Duty capacity correction factors

	Evaporating temperature °F								
ΔT, °F	−40	−30	−20	−10	0	10	20	30	40
9	0.37	0.42	0.45	0.47	0.47	0.49	0.49	0.49	0.50
11	0.48	0.54	0.56	0.61	0.63	0.64	0.64	0.65	0.65
13	0.58	0.66	0.73	0.76	0.78	0.80	0.81	0.82	0.84
15	0.70	0.80	0.88	0.92	0.95	0.97	0.98	1.00	1.01
17	0.80	0.92	1.02	1.09	1.14	1.17	1.18	1.20	1.21
19	0.89	1.04	1.17	1.26	1.31	1.34	1.36	1.37	1.38

Figure Q5b: Duty capacity correction factor

Question 6

Select a suitable model of a thermostatic expansion valve (TXV) for the following application. Refer to information given, table Q6a and Q6b, show the formula, calculation and selection.

Refrigerant = R22
Required valve connection = solder, angleway.
Evaporator capacity Qe = 9kW
Evaporating temperature, Te = -10°C (≈ Pe = 3.6 bar)
Condensing temperature, Tc = 36°C (≈ Pc = 13.9 bar)
Evaporator with six sections.
Size and length of liquid line, diameter ½ inch, Length = 25 m.
Since the evaporator is placed 6 m higher than the receiver, h = 6 m.

GIVEN:

(a) Pressure drop Δp1 in the liquid line. For example: Δp1≈0.1 bar
(b) The assumed pressure drop, p2, in filter drier,sight glass, manual shut-off valve and pipe bends: Δp2 ≈ 0.2 bar.
(c) Find Δp3, in the vertical liquid line.
(d) Pressure drop Δp4 in the liquid distributor: Δp4 ≈0.5 bar
(e) Pressure drop Δp5 in the distributor tubes: Δp5 ≈ 0.5 bar

You are asked to answer the following questions:

(a) Find pressure drop p3.

(2 marks)

(b) Total pressure drop across expansion valve

(5 marks)

(c) Calculate capacity of TXV

(8 marks)

(d) Select a suitable model of TXV.

(5 marks)

Table Q6a: Pressure drop

Refrig-erant	Static pressure drop, Δp_3 bar at height difference h between evaporator and receiver				
	6 m	12 m	18 m	24 m	30 m
R 22	0.7	1.4	2.1	2.8	3.5
R 134a	0.7	1.4	2.1	2.8	3.6
R 404A	0.6	1.3	1.9	2.5	3.2
R 507	0.6	1.3	1.9	2.5	3.2

Table Q6b: TXV selection table

Valve type	Orifice no.	Pressure drop across valve Δp bar							
		2	4	6	8	10	12	14	16
Evaporating temperature –10°C									
TX 2/TEX 2-0.15	0X	0.37	0.47	0.53	0.57	0.60	0.63	0.64	0.64
TX 2/TEX 2-0.3	00	0.79	0.96	1.1	1.2	1.2	1.3	1.3	1.3
TX 2/TEX 2-0.7	01	1.6	2.0	2.3	2.5	2.6	2.7	2.8	2.8
TX 2/TEX 2-1.0	02	2.2	2.9	3.3	3.6	3.8	4.0	4.1	4.1
TX 2/TEX 2-1.5	03	3.9	5.1	5.9	6.4	6.8	7.1	7.3	7.3
TX 2/TEX 2-2.3	04	5.8	7.6	8.7	9.5	10.1	10.5	10.8	10.9
TX 2/TEX 2-3.0	05	7.4	9.6	11.0	12.0	12.8	13.3	13.6	13.8
TX 2/TEX 2-4.5	06	9.1	11.8	13.5	14.7	15.6	16.2	16.6	16.8

Question 7

Referring to attachments 1, 2 and 3, list the following:

(a) Five Mechanical features

(5 marks)

(b) Five control features

(5 marks)

(c) Five Refrigeration system features.

(5 marks)

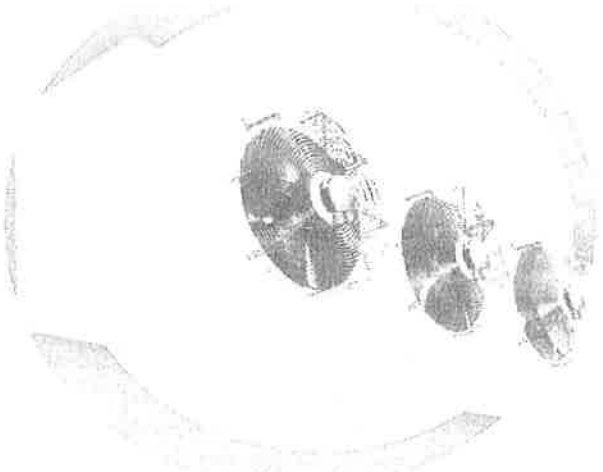
(d)Five electrical features.

(5 marks)

END OF QUESTION

APPENDIX

ATTACHMENT 1



BRB range unit coolers are suitable for chilling or low temperature storage applications.
24 basic models with capacities ranging from 4 to 30,5 kW.

The **BRB** unit cooler line is **EUROVENT** approved.
The ratings indicated are certified compliant to European standard **EN 328**.
www.eurovent-certification.com

RVK Peripheral heaters
ELK Full electrical defrosting (5 coil heaters + 1 drain pan heater)
E1K Light electrical defrosting for BRB F8 and BRB S8 (3 coil heaters)
Renforced electrical defrosting for BRB E7 and BRB D7 (3 additional heaters in the coil)
THD Defrost control thermostat (5709L)
THS Safety thermostat (5708L)
2TH Defrost control and safety thermostat (5709L + 5708L)

BYP Polual Blygold coating of the fins
BAE Coating of the fins (except 4 fan units)
WCO Glycol water and brine
DCF Dual circuit hot/cold

RVU Peripheral heaters
HG1 Hot gas (coil: hot gas, drain pan: electrical heaters)
HGT Hot gas (coil and drain pan)

RCS Electrical heaters on air discharge
VGT Flange of textile duct with guard for aerofoil fan

RFA Streamer
2V5 2 speed 400 V 50 Hz fan assembly
MM5 Single phase 230 V 50 Hz fan assembly
MP5 400 V 50 Hz aerofoil fan
M60 230/400 V 60 Hz three phase fan assembly
CMU* Factory wiring
*CMU = CT5, CT6, CM5 or CM6
CT5 Factory wiring 1 speed 50 Hz
CT6 Factory wiring 1 speed 60 Hz
CM5 Factory wiring 1 speed 230V/1/50 Hz
CM6 Factory wiring 1 speed 230V/1/60 Hz

EDL Expansion valve provided.

EEC Fully equipped unit cooler.

The highly efficient and compact BRB range finned coils are designed with corrugated surface aluminium fins (fin spacing 4,23 or 6.35 mm) and grooved internal structure copper tubes.
The refrigerant distributors are nozzle type (nozzle factory fitted).

An aesthetic white enamelled galvanized steel sheet casing allows for easy cleaning of the unit.
BRB...E7 and BRB...D7 are equipped with an internal drain pan which limits condensation.
The easily removable side panels and the hinged external drain pan allow for easy access to the components of the evaporator (coil, fan assemblies, heater elements, connections...).
The hinging system allows the drain pan to be taken off.

The tubular electric heaters are fitted into pipes expanded in the finned block. One of these heaters is fixed under the intermediate drain pan, thus insuring equal heat distribution for a quick and efficient defrost.
The heaters are factory wired to a terminal block and coupled 400V 3 phase.
Possibility of coupling 230 V 3 phase or 230 V 1 phase.
Defrost water is collected in the intermediate drain pan then drained through a large drain fitting (Ø 1" G).

The BRB unit cooler line is equipped with propeller type fan assemblies, Ø 450 mm, 4 P = 1500 r.p.m., 230-400V, 3 phase, 50 Hz, IP 54, class F, requiring no routine maintenance, with built-in thermal-overload protection **which must be connected externally to effect warranty.**
The high-output, profiled blades operate at a very low noise level.
The fan guards conform to NF E51 190 standard.

ATTACHMENT 2

TECHNICAL DATA

Models			BRB .. F8	76	132	158	199	235	305
Nominal capacity	SC 2 (1) Q_{0m}		kW	7,62	13,17	15,77	19,87	23,51	30,48
Surface			m^2	28,5	38	57	57	86	105
Circuit volume			dm^3	4,85	6,57	9,69	9,58	14,36	17,48
Air flow			m^3/h	3800	8200	7600	12300	11400	14800
	Air throw		m	16	18	18	20	20	22
Fan	Ø 450 mm		No	1	2	2	3	3	4
400 V/3/50 Hz	400V/3/50Hz		W max	1 x 540	2 x 540	2 x 540	3 x 540	3 x 540	4 x 540
1500 r.p.m.			A max (2)	1 x 1	2 x 1	2 x 1	3 x 1	3 x 1	4 x 1
	ELK (3)	Total	W	2100	3000	4200	4200	6000	7200
Electric defrost			A	3,19	4,56	6,38	6,38	9,12	10,94
400 V/3	E1K (3)	Total	W	1050	1500	2100	2100	3000	3600
			A	1,56	2,28	3,19	3,19	4,56	5,47
Net weight			kg	54	92	102	118	135	152

(1) See pages "APPENDIX"
(2) Setting of overload protections.
For room temperatures "ti" other than +20 °C, multiply the given amperage by the ratio 293/(273 + "ti") so as to obtain the approximate amperage after the room pull down.
(3) Electric defrost option.

(●) kit, (○) option

	RVK	ELK	E1K	THD	THS	2TH	BYP	BAE	WCO	DCF	FFP	RVU
BRB ... F8	●	●	●	●	●	●	○	○	○	○	○	○
	HG1	HGT	RCS	VGT	2V5	MM5	MP5	M60	CMU	CT5	C50	EDL	EEC
BRB ... F8	○	-	○	○	○	○	○	○	○	○	○	●	○

TECHNICAL DATA

Models			BRB .. S8	66	104	134	155	201	259
Nominal capacity	SC 2 (1) Q_{0m}		kW	6,56	10,42	13,43	15,54	20,14	25,92
Glycol water*	SC 2 (1) Q_{0m}		kW	-	-	13,04	-	17,07	26,21
Surface			m^2	19,5	26	39	39	60	73
Circuit volume			dm^3	4,85	6,57	9,69	9,58	14,36	17,48
Air flow			m^3/h	4000	8600	8000	12900	12000	15600
	Air throw		m	16	18	18	20	20	22
Fan	Ø 450 mm		No	1	2	2	3	3	4
400 V/3/50 Hz	400V/3/50Hz		W max	1 x 540	2 x 540	2 x 540	3 x 540	3 x 540	4 x 540
1500 r.p.m.			A max (2)	1 x 1	2 x 1	2 x 1	3 x 1	3 x 1	4 x 1
	ELK (3)	Total	W	2100	3000	4200	4200	6000	7200
Electric defrost			A	3,19	4,56	6,38	6,38	9,12	10,94
400 V/3	E1K (3)	Total	W	1050	1500	2100	2100	3000	3600
			A	1,56	2,28	3,19	3,19	4,56	5,47
Net weight			kg	53	92	102	118	135	152

* Glycol water = 30% - Fluid inlet temp. = -8°C - Fluid outlet temp. = -4°C - Dry air = +2°C - Rif = 85%
(1) See pages "APPENDIX"
(2) Setting of overload protections.
For room temperatures "ti" other than +20 °C, multiply the given amperage by the ratio 293/(273 + "ti") so as to obtain the approximate amperage after the room pull down.
(3) Electric defrost option.

(●) kit, (○) option

	RVK	ELK	E1K	THD	THS	2TH	BYP	BAE	WCO	DCF	FFP	RVU
BRB ... S8	●	●	●	●	●	●	○	○	○	○	○	○
	HG1	HGT	RCS	VGT	2V5	MM5	MP5	M60	CMU	CT5	C50	EDL	EEC
BRB ... S8	○	-	○	○	○	○	○	○	○	○	○	●	○

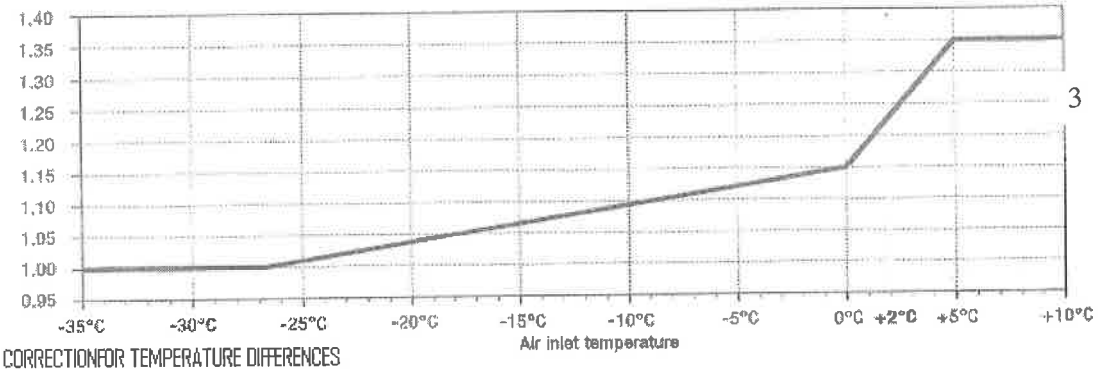
ATTACHMENT 3

STANDARD CONDITIONS

Standard conditions	tA1 Air inlet temperature	te Evaporating temperature	Standard DT1
SC 1	+10 °C	0 °C	10
SC 2	0 °C	-8 °C	8
SC 3	-18 °C	-25 °C	7
SC 4	-25 °C	-31 °C	6

WET COIL FACTOR

Standard conditions	Relative humidity %	Nominal capacity / Standard capacity
SC 1	85	1.35
SC 2	85	1.15
SC 3	95	1.05
SC 4	95	1.01



3

CORRECTIONFOR TEMPERATURE DIFFERENCES

For refrigerant with low (below 1K), or no glide, the capacity shall be assumed to vary directly with the temperature difference between the entering air and dew point evaroratoring temperature i.e:

Required capacity = Nominal capacity wet x Required DT1/Standard DT1.

REFRIGERANT FACTOR

Refrigerant	R 404A/R 507	R 22	R 134a
SC 1	1	0.95	0.93
SC 2	1	0.95	0.91
SC 3	1	0.95	0.85
SC 4	1	0.95	

FIN MATERIAL FACTOR

Aluminium fin	Coated aluminium fin	Copper fin
1	0.97	1.03