UNIVERSITI KUALA LUMPUR
MALAYSIA FRANCE INSTITUTE

FINAL EXAMINATION
SEPTEMBER 2014 SESSION

SUBJECT CODE : FRB30603
SUBJECT TITLE : COLD ROOM AND REFRIGERATED SHOWCASE
LEVEL : BACHELOR
TIME/DURATION : 9.00 AM - 11.00 AM (2 HOURS)
DATE : 4 JANUARY 2015

INSTRUCTIONS TO CANDIDATES

1. All documents authorized (Open Book Examination)
2. Please read the instructions given in the question paper CAREFULLY.
3. This question paper is printed on both sides of the paper.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. This question paper consists only one section. Answer all questions.

THERE ARE 3 PRINTED PAGES OF QUESTIONS, EXCLUDING THIS PAGE
INSTRUCTION: Answer ALL questions.

Please use the answer booklet provided.

Question 1

(a) The freezer room having a dimension of 4.5m x 3m x 3.0 height and the wall thickness is 60mm with the inside design temperature -25°C. 
Floor insulation has a total coefficient of transmission of 0.25 W/m²K while walls and roof made of insulation panels of K = 0.25 W/m²K. 
Outside temperature for 4 walls is 28°C, ground temperature is 27°C and roof 35°C. 
Storage capacity is 450 kg with daily loading/unloading rate 45 kg at -18°C and a specific heat of 1.8 kJ/kgK. 
It handling by 2 motorized pallet truck of 2 kW each and daily net 3 hours are operating inside the cold room. 
There is 1 automatic door for entry and exit each, have a dimension 2.0 m H x 1.5 m W equipped with air curtains. 
External conditions is 28°C, RH 70 % enthalpy 64 kJ/kg density 1.15 kg/m³ and internal conditions -20°C, RH 95 % enthalpy -25 kJ/kg density 1.43 kg/m³. 
Time for opening of the door for the passing of power lifts: 50 kg: 45 s 
Lighting is 6 x 200W operating for a duration of 8 hours net per day 
2 occupants for a net duration of 2 hours net per day and release heat 250 W/ person 
Calculate the hourly refrigerating power for a maximum running time 18 hours per day. 

(b) In order to save energy, it is proposed that the incandescent lights be replaced by 3 high efficiency fluorescent tubes, each consuming 40W. If the lights are on for an average of 8 hr a day, every day, determine the amount of electrical energy and money this facility will save per year? Assume the refrigeration system has a COP of 3 and the cost of electricity is $0.35/kWh.

Question 2

Draw the complete refrigerating diagram of principle on the basis of three (3) screw compressor, commom oil separator, commom oil cooler, air cooled condenser, high pressure bottle, expansion valve and low pressure bottle without pump (using gravity force) supplying the evaporator.

(4 marks)
Question 3

(i) Explain clearly about control of microorganisms in food highlighting the following:

i. What are the major causes of food spoilages?

ii. Differentiate between (a) enzymes (b) Yeast (c) Bacteria (d) Mold

iii. Four environmental factors that affects growth of microorganism

iv. How can the microorganisms in foods be destroyed

(2Marks)

(ii) Fresh strawberries with a water content of 80.9% (by mass) at 26°C are stored in 0.8 kg boxes made of polyethylene (Cp=2.3 kJ/kg °C). Each box contain 25 kg strawberries, and the strawberries are to be frozen to an average temperature of -16°C at a rate of 80 boxes per hour. The enthalpy of the strawberries is given to be 367 kJ/kg at 0 °C and 54 kJ/kg at -16 °C. Taking the average specific heat of the strawberries above freezing temperature to be Cp =3.94 kJ/kg °C, determine the rate of heat removal from the strawberries and their boxes, in kJ/h.

(2Marks)

QUESTION 4

The chilling room of a meat plant is 18m x 18m x 6m in size and has a capacity of 350 beef carcasses. The power consumed by the fans and the lights of the chilling room are 22 kW and 2 kW, respectively, and the room gains heat through its envelope at a rate of 11 kW. The average mass of beef carcasses is 300 kg. The carcasses enter the chilling room at 35°C, after they are washed to facilitate evaporative cooling, and are cooled to 16°C in 10 hr. The water is expected to evaporate at a rate of 0.080 kg/s. The air enters the evaporator section of the refrigeration system at 0.5°C and leaves at -2.2°C. The air side of evaporator is heavily finned, and the overall heat transfer coefficient of the evaporator based on the air side is 22 W/m² °C. Also, the average temperature difference between the air and the refrigerant in the evaporator is 6.5°C. Determine:

(i) The refrigeration load of the chilling room

(ii) The volume flow rate of air

(iii) The heat transfer surface area of the evaporator on the air side.

(4 marks)
QUESTION 5

(i) An R-134a commercial refrigerator has a design capacity of 4 tons and operates with a saturated suction temperature of 40°F and a saturated condensing temperature of 120°F. The copper suction line is 52 ft long and has 20 equivalent ft of fittings and valves. Select the proper size for the suction line.

(ii) An R-134a commercial refrigerator has a design capacity of four tons. It operates with a saturated suction temperature of 40°F and a saturated condensing temperature of 120°F. The copper discharge line is 30 ft long and has 10 equivalent ft of fittings and valves. Select the proper diameter for the discharge line.

(iii) Sketch the location of hot gas defrost line and explain its function.

(2 marks)

END OF QUESTION
### APPENDIX 2

#### SPA(E)...C

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*Multiple injection via flow distributor. ** KUJA-CAL® distributor.

*** Modification of sound power level, see page 47.

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**Q0 Diagram (R22, R134A, R404A, R507)**

- **t11 [°C]** Air inlet temperature
- **Q0 [kW]** Capacity

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**FRB30603 COLD ROOM AND REFRIGERATED SHOWCASE**
## Technical data

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**Multiple injection via X08A-CAL® distributor**

**Modification of sound power level, see page 47**

**Qᵥ diagram (R22, R134A, R404A, R507)**

- **Qᵥ [kW] Capacity**
- **ΔT [°C] Air inlet temperature**

See page 47 for information about Qᵥ diagram
### Leistungswerte bezogen auf 20°C Sauggastemperatur mit Flüssigkeits-Unterkühlung, 50 Hz

#### Performance data based on 20°C suction gas temperature with liquid subcooling, 50 Hz

#### Données de puissance se référant à une température de gaz aspiré de 20°C avec sous-refroidissement, 50 Hz

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© Leistungsaufnahme des Verdichters. Werte für Verflüssiger-Lüfter siehe "Technische Daten" (Seite 18 und 19)

© Power consumption of compressor. Values for condenser fans see "Technical data" (page 18 and 19)

© Puissance absorbée du compresseur. Pour les valeurs des condenseur-ventilateurs voir "Caractéristiques techniques" (page 18 et 19)

---

FRB30603 COLD ROOM AND REFRIGERATED SHOWCASE

7
### Technische Daten

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<th>max. Stromaufnahme</th>
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<th>Consomm. de courant</th>
<th>Puissance absorbée</th>
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Thermophysical Properties of Refrigerants

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<tr>
<th>Temp. °C</th>
<th>Pressure, kPa</th>
<th>Density, kg/m³</th>
<th>Enthalpy, kJ/kg</th>
<th>Entropy, kJ/kg K</th>
<th>Specific Heat, kJ/kg K</th>
<th>Volume, m³/kg</th>
<th>Viscosity, cSt</th>
<th>Density, kg/m³</th>
<th>Value, m³/kg</th>
<th>Value, cSt</th>
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* Temperatures on ITS-90 scale
** Triple point
--- Normal boiling point
* Critical point

FRB30603 COLD ROOM AND REFRIGERATED SHOWCASE