Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE SEM-V Examination-Nov/Dec.-2011

Subject code: 151403 **Date: 24/11/2011**

Subject Name: Food Refrigeration and Air Conditioning

Time: 2.30 pm -5.00 pm **Total marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 (a) Answer the following questions: **07**

(i) Define COP of refrigeration system
(ii) State the safety criteria for selection of refrigerants.
(iii) Write chemical formula for R 717 and R118
(iv) Show that 1 TR = 3.5167 kW
(v) What are azetropes?
(vi) What are cryogenic fluids?
(vii) How can leakage of refrigerants detected?

(b) In an absorption type refrigeration system, heat is supplied to NH_3 generator by condensing steam at 2 bar and 85% dry. Find the maximum COP possible of the refrigerator if the temperature to be maintained in the refrigerator is – 4 ^oC and atmospheric temperature is 30^oC. If the refrigeration load is 10 Tons and actual COP is 75% of maximum COP, find the mass of steam required per hour. Assume that only latent heat of steam is used for heating purpose. **07**
[Given: Saturation temperature of steam at 2 bar = 12 ^oC; h_{fg} = 2200 kJ/kg]

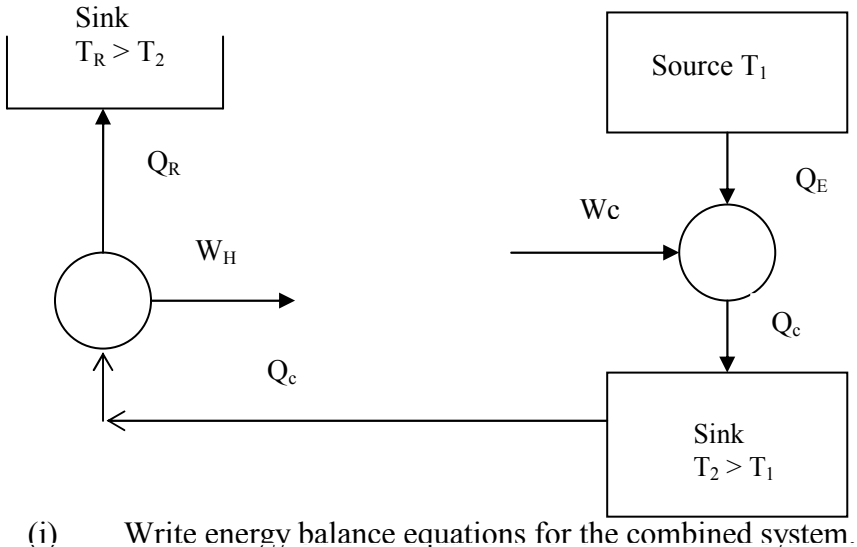
Q.2 (a) **Q-3** A simple vapour compression refrigeration system produces 20 TR of refrigeration effect using R-22 as a refrigerant. If the condensing and evaporating temperatures are 40^oC and -10^oC respectively, calculate **07**

(i) Refrigeration effect per kg of refrigerant in TR/kg.
(ii) Refrigerant circulation rate in kg/s
(iii) Compressor Power used in kW
(iv) Actual System COP
(v) Carnot COP
(vi) Refrigeration Efficiency in %
(vii) Compressor displacement in m^3/s

R-22 Properties

t (^oC)	h_g kJ/kg	h_f kJ/kg	s_g kJ/Kkg	s_f kJ/Kkg	v_g m^3/kg	v_f m^3/kg	C_P kJ/Kkg	P bar
- 10 ^oC	401.56	188.43	1.77	0.96	0.0654	$0.76X10^{-3}$	0.686	3.54
40^oC	416.56	249.69	1.69	1.116	0.151	$0.884X10^{-3}$	1.0	15.33

(b) A refrigeration system and a heat engine are coupled together to operate as a single unit as shown in the figure: **07**



(i) Write energy balance equations for the combined system.
(ii) Calculate compressor work in kW
(iii) Calculate work output of the heat engine in kW

Given: Efficiency of heat engine = 30%
Refrigeration capacity = 2 TR
COP (Refrigeration) = 4

OR

(b) With the help of P-h chart explain objectively the effect of the following parameters on the performance of a simple vapour compression refrigeration system: **07**

(i) Evaporator pressure (ii) Condenser pressure
(iii) Suction vapour superheat. (iv) Liquid sub-cooling

Q.3 **(a)** Explain (i) 'Green House Effect' *vis-à-vis* CFC emissions. **04**
(ii) Cause of 'Ozone layer' depletion in the stratosphere.

(b) Explain the function of the following: **05**
(i) Time Switches (ii) Air washers
(iii) Limit Switches (iv) Thermostatic expansion valve
(v) Solenoid valve

(c) A fan motor rated at 15 Ampere is consuming 11 Ampere while generating a rotational speed of 15 rad/s. What is the maximum permissible rotational speed that can be achieved? What percent increase in air flow is possible? **05**

OR

Q.3 **(a)** Explain the functions of the following: **04**
(i) Air dampers (ii) Capillary tube
(iii) Condenser (iv) Propeller fans

(b) A fan running at 760 RPM is generating an air flow of 600 m^3/hour, developing a static pressure of 15 mm WC and consumes 0.10 HP power. If the fan speed is doubled, calculate the following: **05**

(i) Air flow rate in m3/minute.
(ii) Static pressure in mm WC.
(iii) Power consumption in HP.

(c) Write basic mass and energy balance equations for air flow through ducts. State the general rules for duct design and the preferred materials for its construction. **05**

Q.4 **(a)** Explain the construction and working of a Domestic Electrolux Refrigerator with neat sketch. **07**

(b) Classify different types of compressor. Briefly explain the principle, construction and working of a water cooled condenser. **07**

OR

Q.4 **(a)** What do you mean by sensible heat and latent heat? Find the refrigeration load expressed in tons of refrigeration which is caused by heat loss from the four wall of a small cold storage room 3.0 m X 6 m X 3.0 m. The walls are made of 20 cm brick, 10 cm cork board and 1 cm cement plaster with their respective thermal conductivities of 0.6 $Wm^{-1o}C^{-1}$, 0.04 $Wm^{-1o}C^{-1}$and 0.8 $Wm^{-1o}C^{-1}$. Inside wall temperature is -4^oC and outside wall temperature is 35^oC. Add a factor of safety = 2 for losses through joints. (Assume 1 TR = 3.519 kJs^{-1}) **07**

(b) "An ideal vapour absorption system may be considered as equipment combining a heat engine and a mechanical refrigerator working together to produce desired refrigeration effect". Justify the statement with help of suitable line diagram and a mathematical expression. **07**

Q.5 **(a)** Briefly explain various components of a cold storage and list out different safety devices used in a cold storage with their respective location. **07**

(b) Differentiate between Controlled atmosphere storage and Modified atmosphere storage. Write a short note on Individual quick freezing (IQF) in food refrigeration. **07**

OR

Q.5 **(a)** What are the limitations of vapour compression refrigeration system for production of low temperature? What do you mean by cascade refrigeration? **07**

(b) List out different types of expansion valves. With help of a labeled diagram, explain the working of single-stage centrifugal compressor mentioning all components. **07**

****