MCV390 : PRODUCT DESIGN IN REFRIGERATION & AIRCONDITIONING
WRITTEN TEST

DATE : 26.4.17 TIME : 12.00pm -1.30pm M.M. : 40

Attempt all questions

1) Illustrate the Design process from identification of a need to product launch in market. You need not limit the example to refrigeration and air-conditioning needs. Illustration of each step should be done by describing the activity briefly

(4)

2) a) The highest possible efficiency of the air-conditioning system is limited by which ideal thermodynamic cycle?
   b) What is the Ideal Energy Efficiency of an Air conditioner if the outdoor air temperature is 43^{O}C and Indoor Air temperature is 25^{O} C.
   c) Real Refrigeration and Air-conditioning systems follow which cycle?

(1X3)

3) Identify any 3 reasons why a real system will have an efficiency lower than the ideal system. Illustrate using a pressure enthalpy diagram of R-22.

(3)

4) Compare the annual energy cost of a variable speed air-conditioner with that of a fixed speed system. The fixed speed AC has an EER of 3.5 at full load. The variable speed system has an EER as a function of cooling capacity as follows:

Cooling Capacity	EER	Operating Hours
5250	3.3	2%
4000	3.7	18%
3000	4.2	50%
2000	4.5	20%

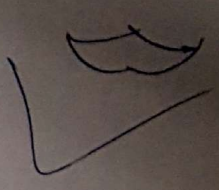
Use the following assumptions:

a) The Cooling capacity of fixed and variable speed units is 5250 KW at full load.
b) The duration of operation is 240 days in a year 24X7.
c) Indoor Conditions are constant and equal to the test conditions for rating EER.
d) Cost of Energy is Rs 6.00/KWh
e) The Outdoor Test condition for full load and part load EER is 35^{O}C Outdoor Air Temperature. The % hours and EER multiplier is as follows for the actual temperature. Assume proportional spread of outdoor temperature for the part load operation.
f) Assume part cooling capacity operating hours in table above for both types of units.

Outdoor Air (^{O}C)	% Hours	EER multiplier
24-29	60	1.2
30-34	29	1.1
35	3	1.0
36-48	8	0.88

If the Variable Speed unit cost Rs 8000/- more, what is the payback period?

(7)



Heat from cold / ~~Heat input~~ Work input

$\frac{T_c}{T_h - T_c} = \frac{298}{316 - 298}$

5) In which of the following compressor types, the motor heat is rejected to the refrigerant?
   i) Rotary
   ii) Reciprocating
   iii) Scroll
   b) How does this influence the reliability and efficiency of refrigeration system?

(1,2)

6) Explain giving a precise reason if the following statements are true or false.
   a) Thermostatic Expansion Valves with external equalizer are required for small evaporators with a low evaporator pressure drop.
   b) Multiple refrigerant circuits in an evaporator are used to optimize heat transfer and pressure drop.
   c) A Scroll compressor compresses refrigerant dynamically.
   d) The refrigerant mass flow rate through a Reciprocating compressor is influenced by the discharge pressure while that is not the case for Scroll compressors.
   e) An expansion valve with bleed port allows a reduced starting torque for the compressor.
   f) An application having large periods of part load operation will have a short time period for payback of high initial cost variable cooling capacity systems.
   g) The minimum stable superheat is a function of Thermostatic Expansion Valve selection.
   h) Flammable Refrigerants are now widely used in refrigerators with small refrigerant charge.

(8X1)

7)
   a) What are the two main reasons for sub-cooling refrigerant?
   b) Which component of the refrigeration system will require re-design for increasing sub-cooling?

(2X1)

8) When assessing refrigerant suitability for Indian Climatic conditions in comparison to Europe, what refrigerant property would you specifically focus on and how would it impact the energy required for air-conditioners.

(2)

9) A large refrigeration system in a cold room operates at -23^{O}C evaporating temperature and you are called in make a recommendation for an expansion valve to protect the compressor from overload during pull down. What unique characteristic will you specify in the expansion device and what is the principle of operation? What are the other selection parameters?

(3)

10) In fin on tube heat exchangers what are the different surface enhancements for increasing heat transfer? What are the different types of coatings used for?

(2)

11)
   a) What are the two main environmental concerns that are influencing the choice of refrigerants?
   b) Describe the Refrigerant safety classifications.
   c) What are the reasons to move away from R-22 as a refrigerant for air-conditioning? Which are the alternatives to R-22 and their risks

(3X1)