Menoufia University	**Faculty of Engineering**
Mech. Power Eng. Dept.	**Post-graduate (Diploma)**
Subject: Refrigeration cycles	**Final Exam: 2014/2015**
Total mark: 100 (mark)	**Time allowed: 3 hours.**

Refrigeration charts are allowed.

Answer the following questions:

Question (1): **[20 mark]**

A single stage vapour absorption refrigeration system based on H2O-LiBr has a refrigeration capacity of 300 kW. The system operates at an evaporator temperature of 5°C (Psat=8.72 mbar) and a condensing temperature of 50°C (Psat=123.3 mbar). The exit temperatures of absorber and generator are 40°C and 110°C respectively. The concentration of solution at the exit of absorber and generator are 0.578 and 0.66, respectively. Assume 100 percent effectiveness for the solution heat exchanger, exit condition of refrigerant at evaporator and condenser to be saturated and the condition of the solution at the exit of absorber and generator to be at equilibrium. Enthalpy of strong solution at the inlet to the absorber may be obtained from the equilibrium solution data.

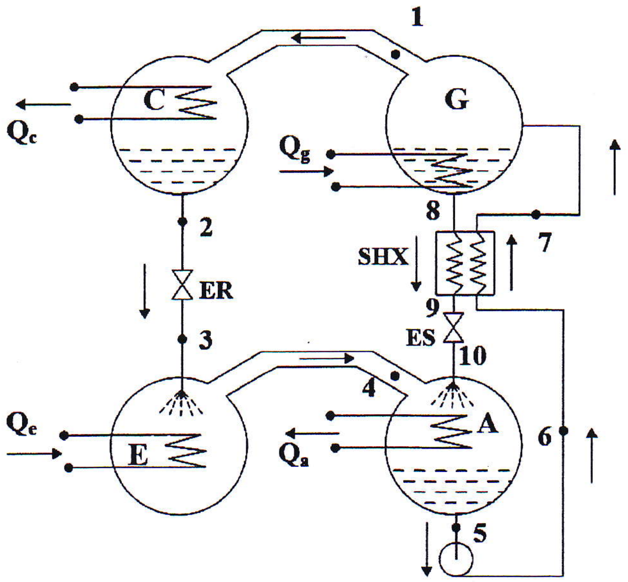
Find:

a) The mass flow rates of refrigerant, weak and strong solutions

b) Heat transfer rates at the absorber, evaporator, condenser, generator and solution heat exchanger

c) System COP and second law efficiency, and

d) Solution pump work (density of solution = 1200 kg/m^3).



Question (2): **[30 mark]**

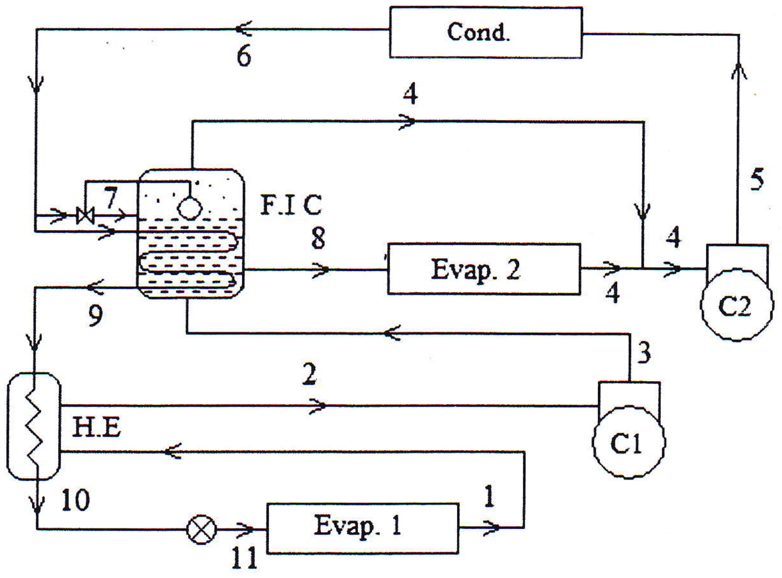
An ammonia refrigeration system consists of two stages compressors, two evaporators, flash intercooler and sub-cooler, heat exchanger and condenser. Ammonia vapor condenses in the condenser at 40 °C. The amount of liquid refrigerant goes to the low temperature evaporator is sub-cooled 10 °C in the liquid sub-cooler and another 10 °C in the liquid-vapor heat exchanger. Vapor leaves the low pressure evaporator saturated at -30 °C, and then it is superheated in the heat exchanger at the same pressure. The vapor comes out the flash intercooler and high pressure evaporator saturated at 4 bar. The cooling capacities of the L.P. and H.P. evaporators are 15 T.R. and 35 T.R. respectively.

Calculate; (a) Refrigerant mass flow rates through each evaporator,

(b) Refrigerant mass flow rate though each compressor,

(c) The power required for each compressor,

(d) Heat rejected in the condenser, and (e) The C.O.P. of the system.



Question (3): **[50 marks]**

a) Explain with drawing sketches the Bootstap air refrigeration system. (5 mark)

B)Explain with net diagram the working principles of NH_3-H_2O absorption refrigeration system. (5 mark)

c) Note: **Write your answer (X) or (√) only in your notebook of answer.**

False or true: (40 mark)

1- Subcooling is beneficial as it decreases work of compression.

2 -Superheating always increases specific refrigeration effect.

3 - Degree of superheating obtained using a LSHX is always greater than the degree of subcooling.

4 - Pressure drop and heat transfer in suction line increase compression ratio & discharge temperature.
5 - Multi-evaporator systems are used when humidity control in the refrigerated space is required.
6 - Using intercooling in multi-stage compression systems work of compression in higher stage compressor can be reduced.
7 - Refrigeration system with liquid subcooler is used to prevent flashing of refrigerant liquid ahead of low stage expansion device.
8 - In two-stage compression system with flash gas removal Refrigerant mass flow rates in high stage compressors is smaller than that in low stage compressor.
9 - Compared to compression systems, absorption systems offer the benefits of possibility of using low-grade energy sources.
10 - Absorption of the refrigerant by the absorbent in a vapour absorption refrigeration system is accompanied by absorption of heat.
11 - The conventional, continuously operating single stage vapour absorption refrigeration system uses a thermal compressor in place of a mechanical compressor.
12 - Water-lithium bromide systems are used for refrigeration applications above $0^{o}C$ only.
13 - Ammonia-water systems can be used for refrigeration applications below $0^{o}C$ only.
14 - Vapour absorption refrigeration systems using water-lithium bromide operate under vacuum.
15 - For a required refrigeration capacity, the solution heat exchanger used in water-lithium bromide systems reduces the required heat source temperature.
16 - In water-lithium bromide systems, the required heat source temperature should be higher than minimum heat generation temperature.
17 - In water-lithium bromide systems, the required heat source temperature is higher for air cooled condensers, compared to water cooled condensers.
18 - In commercial water-lithium bromide systems, the system capacity is regulated by, controlling the temperature of heating fluid to generator.
19 - In an ammonia-water system a rectification column is used mainly to improve the COP of the system.
20 - Compared to compression systems, absorption systems require regular maintenance.