B.Tech Odd Semester (CBCS) Exam., December—2017

AGRICULTURAL ENGINEERING

(7th Semester)

Course No. : AE–701 (C)

(Refrigeration and Air-Conditioning)

Full Marks : 75
Pass Marks : 30

Time : 3 hours

Note : 1. Attempt **one** question from each Unit.
2. Begin each answer in a new page.
3. Answer parts of a question at a place.
4. Assume reasonable data wherever required.
5. The figures in the margin indicate full marks for the questions.

UNIT—1

1. *(a)* Define the following : 2×5=10

(i) Dew-point temperature

(ii) Enthalpy

(iii) Relative humidity

(iv) Dry-bulb temperature

(v) Wet-bulb temperature

(b) Air at 35° C, 40% RH is mixed adiabatically with air at 40° C, 40% RH in the ratio of 1 kg of former with 2 kg of later (on dry basis). Find the final condition i.e. humidity and enthalpy of air. Assume that weight of moisture content in first and second conditions are 0·0028 kg/kg of dry air and 0·003 kg/kg of dry air, respectively. 5

2. *(a)* What are different psychrometric processes? 3

(b) Define specific volume and hygroscopic materials. 4

(c) A cooling tower is used for cooling the condenser water of a refrigeration system having a heat rejection rate of 100 kW. In the cooling tower air enters at 35° C (DBT) and 24° C (WBT) and leaves the cooling tower at a DBT of 26° C and relative humidity of 95%. What is the required flow rate of air at the inlet to the cooling tower in m^3/s and what is the amount of make-up water to be supplied? The temperature of make-up water is at 30° C, at which its enthalpy may be taken as

125·4 kJ/kg. Assume the barometric pressure to be 1 atm. Also assume that humidity ratio, enthalpy and specific volume for the inlet are 0·01426 kg/kg of dry air, 71·565 kJ/kg of dry air and 0·89284 m^3/kg of dry air, respectively, while for the outlet, assume humidity ratio and enthalpy are 0·02025 kg/kg of dry air and 77·588 kJ/kg of dry air, respectively. 8

UNIT—2

3. *(a)* What are the major components of a refrigeration system? 2

(b) What are primary and secondary refrigerants? 2

(c) Elaborately explain about all the chemical properties of refrigerants. 6

(d) A house refrigerator of 1 TR capacity operates half the time during 13-hour long days and 30% time during the nights. If COP is 4·7, then at ₹ 3/ kWh, monthly (30 days) how much will be the electricity bill for that particular refrigerator? 5

4. *(a)* A cold storage plant is required to store 50 tonnes of apples. The initial temperature of apples is 28° C and refrigerated storage temperature is 2° C. The specific heat of apple above freezing point is 3·64 kJ/kg °C. The cooling is to be achieved within 10 hours. Then find out the capacity of the refrigeration plant. 6

(b) What are the differences between air-cooled and water-cooled condensers? 4

(c) Milk having weight of 98000 N and specific heat capacity 3·8 kJ/kgK is to be chilled from 40° C to 5° C in one hour in a chilling plant using a refrigerant whose COP is 4·7. Calculate the total power required for chilling assuming compressor power consumption with 100% efficiency. 5

UNIT—3

5. *(a)* What is vapour-compression refrigeration system and what are the processes involved in vapour-compression refrigeration system? 2+4=6

(b) What are different types of refrigerant expansion devices? 3

(c) The below table provides steady-state operating data for a vapour-compression refrigeration cycle using R-134a as the working fluid. For a refrigerant mass flow rate of 0·08 kg/s

State	1	2	3	4
h (kJ/kg)	241·35	280·15	91·49	91·49

determine the—

(i) compressor power, in kW;

(ii) refrigeration capacity, in tons;

(iii) coefficient of performance. 3

(d) What are the features of actual vapour-compression cycle? 3

6. *(a)* What are the basic functions of an expansion device used in refrigeration systems? 1

(b) What is the purpose of the compressor in refrigeration systems? 3

(c) What are the advantages and disadvantages of vapour-compression refrigeration system over air-refrigeration system? 3

(d) Define the following : 2×4=8

(i) Vapour-absorption cycle

(ii) Evaporative condensers

(iii) Natural and forced convection-type evaporators

(iv) Shell-and coil-type condensers

UNIT—4

7. *(a)* Explain the principle of steam-jet refrigeration. 4

(b) Where is steam-jet refrigeration system widely used and what are the advantages and disadvantages of steam-jet refrigeration systems? 8

(c) Can thermoelectric systems be used for heating, as well? 3

8. *(a)* What are the special features of the water-lithium bromide solution? 4

(b) Why are the two types of material (P and N) required for thermoelectric refrigeration? 5

(c) Define the following : 6

(i) Vortex tube refrigeration systems

(ii) Absorption refrigeration systems

UNIT—5

9. *(a)* Elaborately explain about the methods of estimating cooling and heating loads. 4

(b) Define humidifier and dehumidifier. 3

(c) How to increase the efficiency and life of any heating or cooling system? 2

(d) What are the things have to be taken care while choosing a new air-conditioning unit? 2

(e) A building has a U value of 0·5 W/m^2K and total exposed surface area of 384 m^2. The building is subjected to an external load (only sensible) of 2 kW and an internal load of 1·2 kW(sensible). If the required internal temperature is 25° C, state whether a cooling system is required or a heating system is required when the external temperature is 3° C. How will the results change, if the U value of the building is reduced to 0·36 W/m^2K? 4

10. *(a)* What are various types of application of air-water systems? 2

(b) What are various components that constitute the cooling load on a building? 5

(c) If energy prices continue to escalate, what would be the most effective in controlling home comfort costs? 3

(d) What is the classification of air-conditioning systems based on the use of fluid media? What are the advantages and disadvantages of air-water systems? 5

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