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Courses » RAC Product Design

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Unit 5 - WEEK 3

Course outline

How to access the portal

Pre-requisite ASSIGNMENT

WEEK 1

WEEK 2

WEEK 3

 Condensers and Evaporators Types of Heat Exchangers and Air Conditioning Systems Selection of Air Conditioning Systems for Hostels Case Study on a Railway Air Conditioning System Quiz : Assignment 3

WEEK 4

Solution of Assignment Problems

Assignment 3

The due date for submitting this assignment has passed. **Due on 2018-09-16, 23:59 IST.**
As per our records you have not submitted this assignment.

(A)

1) Which of the following is not a design consideration for a railway air conditioning system? **1 point**

- Ambient conditions
- Power supply
- Space availability
- Shunting shocks
- Water cooling arrangement for condensers

No, the answer is incorrect.**Score: 0****Accepted Answers:***Water cooling arrangement for condensers*2) The air or refrigerant pressure drop would be higher for **1 point**

- Refrigerant flow in a micro-channel heat exchanger than for a fin and tube heat exchanger having equal distance between inlet and outlet.
- Air flow over a fin on tube heat exchanger with staggered tube arrangement Vs another similar sized heat exchanger with inline tube configuration.
- Refrigerant flow in a fin on tube evaporator with longer distance between tube sheets than another fin on tube heat exchanger with a shorter distance between tube sheets. Face area, number of vertical rows, tube diameter, tube pitch and tube configuration are same for both heat exchangers.
- Higher fin pitch heat exchanger than the one with lower fin pitch with all other parameters being equal.

No, the answer is incorrect.**Score: 0****Accepted Answers:***Refrigerant flow in a micro-channel heat exchanger than for a fin and tube heat exchanger having equal distance between inlet and outlet.**Air flow over a fin on tube heat exchanger with staggered tube arrangement Vs another similar sized heat*

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- Brazed plate heat exchanger
- Microchannel heat exchanger

No, the answer is incorrect.

Score: 0

Accepted Answers:

Brazed plate heat exchanger

4) The condenser in a real refrigeration system does

1 point

- De-superheating and condensation
- Sub-cooling and condensation only
- De-superheating, condensation and sub-cooling
- Condensation only
- none of above

No, the answer is incorrect.

Score: 0

Accepted Answers:

De-superheating, condensation and sub-cooling

5) Which of the following are not recommendable practices in heat exchanger design for RAC systems?

2 points

- Usage of flat fin shape for reducing ice accumulation.
- Use of Louvered fins in air cooled condensers in highly dusty areas.
- Use of Tube internal surface enhancement in evaporators where air side heat transfer is high.
- Adding a hair pin to a circuit of high superheat in an evaporator coil to balance heat transfer between different circuits.

No, the answer is incorrect.

Score: 0

Accepted Answers:

Use of Louvered fins in air cooled condensers in highly dusty areas.

Adding a hair pin to a circuit of high superheat in an evaporator coil to balance heat transfer between different circuits.

6) Fin on tube evaporators are most widely used in

2 points

- Domestic Direct Cooling type refrigerators
- Window AC
- Split AC
- Water Cooler
- none of above

No, the answer is incorrect.

Score: 0

Accepted Answers:

Window AC

Split AC

7) Which of the following statements is/are TRUE?

2 points

- Compared to water cooled condensers, the maintenance cost is low in air cooled condensers
- Normally, systems with water cooled condensers operate at lower condensing temperatures as compared to systems with air cooled condensers
- The initial cost of water cooled condenser is high compared to air cooled condenser

Micro channel heat exchanger could be used for R134A

No, the answer is incorrect.

Score: 0

Accepted Answers:

Compared to water cooled condensers, the maintenance cost is low in air cooled condensers

Normally, systems with water cooled condensers operate at lower condensing temperatures as compared to systems with air cooled condensers

The initial cost of water cooled condenser is high compared to air cooled condenser

Micro channel heat exchanger could be used for R134A

8) Which of the following is true for AC systems for a multi indoor system?

2 points

COP of a chiller with FCUs > COP of multiple split units with VRV

COP of a chiller with FCUs < COP of multiple split units with VRV

System breakdown risk due to refrigerant leak in a chiller with FCUs > System breakdown risk due to refrigerant leak in systems with multiple indoor units connected to multiple outdoor units in variable refrigerant flow systems.

System breakdown risk due to refrigerant leak in a chiller with FCUs < System breakdown risk due to refrigerant leak in systems with multiple indoor units connected to multiple outdoor units in variable refrigerant flow systems.

No, the answer is incorrect.

Score: 0

Accepted Answers:

COP of a chiller with FCUs < COP of multiple split units with VRV

System breakdown risk due to refrigerant leak in a chiller with FCUs < System breakdown risk due to refrigerant leak in systems with multiple indoor units connected to multiple outdoor units in variable refrigerant flow systems.

9) Pickup the true statements among the following:

2 points

Hydrophilic coatings are used for evaporators for preventing water accumulation on the tubes.

Hydrophilic coatings are used in fin on tube evaporators for preventing water

Variable Speed AC systems allow for addressing cooling loads with a lower overall system capacity in comparison to 1:1 systems due to diversity in usage of the occupied spaces.

The power required by the supply air fan in a residential split wall mounted AC unit is higher than the power required by condenser fan of the same unit.

A fixed speed AC unit is preferable over an inverter compressor AC when the number of operating hours at part load conditions is high.

No, the answer is incorrect.

Score: 0

Accepted Answers:

Hydrophilic coatings are used in fin on tube evaporators for preventing water

Variable Speed AC systems allow for addressing cooling loads with a lower overall system capacity in comparison to 1:1 systems due to diversity in usage of the occupied spaces.

(B) A condenser of a room air conditioner is designed to reject heat at a rate of 2.78 kW from R134a refrigerant as it condenses at 40C. Air ($C_p=1005 \text{ J/kg.C}$) flows across the finned condenser coils, entering at 20 C and leaving at 30 C. If overall heat transfer coefficient based on the refrigerant side is $180 \text{ W/m}^2\text{K}$,

10) Determine the heat transfer area on the refrigerant side.

Note:- Answer is in m^2 , Only enter the value.

No, the answer is incorrect.

Score: 0**Accepted Answers:***(Type: Range) 0.5,1.5***2 points**

11) Determine the volumetric flow rate of air

Note- Answer is in m³/hr. Only give the value.**No, the answer is incorrect.****Score: 0****Accepted Answers:***(Type: Range) 750,950***2 points**

12) If the air cooled condenser is replaced by a water cooled one, maintaining the same condenser temperature and with water inlet and outlet temperatures the same as that of the air cooled one, determine the heat transfer area required if the overall heat transfer coefficient is 1100 W/m²K.

Note- When using a water cooled condenser, the condensation temperature would actually reduce and the water temperatures would be lower than that of air. This problem assumes them to be the same to highlight the reduction in surface area achievable using a water cooled condenser.

Answer is in sq.m, only enter the value.**No, the answer is incorrect.****Score: 0****Accepted Answers:***(Type: Range) 0.17,0.18***3 points**

(C) A water-cooled condenser has the following details :

Condenser saturation temp. = 48.9 C

Coolant inlet temperature = 37.8 C

Coolant flow rate = 20.694 kg/s

Heat rejected by condensor = 650 kW. Assume that the entire heat of rejection of the condenser is in the saturation temperature zone

13) Determine the product 'UA' (in kW/K) for the heat exchanger. Where U is the overall heat transfer coefficient and A is the heat transfer surface area.

Note - Answer is in (kW/K), only enter the Value**No, the answer is incorrect.****Score: 0****Accepted Answers:***(Type: Range) 95,100***2 points**

14) Determine the heat transfer rate to the coolant water when the water inlet temperature is 30C and the condensor saturation temperature is 42C, assuming the same overall heat transfer coefficient.

Note- Answer is in kW, only enter the value**No, the answer is incorrect.****Score: 0**

Accepted Answers:
(Type: Range) 600,800

2 points

15) An AC system with R22 as the refrigerant is operating with the condenser conditions stated in Q14. The evaporator temperature is 2 °C. Determine the AC system cooling capacity assuming an standard VCR cycle.

Note- Answer is in TR, Only give the value.

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Range) 166,172

3 points

(D) A room in a building has the following parameters for its VAV cooling system:

- Room temperature: 25C, 50%RH
 - Cooling Coil outlet temperature: 12.8 C, 80%RH
 - Supply air temperature rise across fan : 0.5C
 - Supply air flow rate: 2 kg/s
 - Fan motor power: 2.2 kW
- The bin distribution of total loads on a particular day are as follows:

Bin	Hours	Total load (kW)
1	4	26.75
2	8	25.86
3	7	24.98
4	5	24.1

Supply air DBT (in C)	AC EER
12-14	3.0
14-16	3.1
16-18	3.2

The fan power consumption using a VFD drive for adjustable speeds is given by the equation

$$W_{fan} = \text{Power}(\text{Rated}) \times (0.033 + 0.1523(\text{PLR}) + 0.5993(\text{PLR})^2 + 0.2559(\text{PLR})^3)$$

Where, PLR is part load ratio defined by the ratio of air flow rate to the rated flow rate capacity of the fan.

Taking a ventilation rate of 0.8 kg/s and an average outside air condition of 30C, 60%RH,

16) Determine the total energy consumption for the 4 bins, using a VFD drive

Note- Answer is in kWh, only enter the value.

No, the answer is incorrect.
Score: 0

Accepted Answers:

(Type: Range) 320,420

3 points

17) It is decided to maintain the same flow rate, but vary the supply air inlet conditions for the AC system corresponding to the 4 bins. Determine the energy savings for the fan using the VFD drive in comparison with this method .

Note- Answer is in %, Only enter the value

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 45,55

1 point

18) Determine the energy savings (in %) for the total system using the VFD drive in comparison with the method used in Q17.

No, the answer is incorrect.

Score: 0

Accepted Answers:

(Type: Range) 1.2,2.5

3 points

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