BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration & Air Conditioning Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, III Semester,

End-Sem. Examination

Course Code: HVA1301 **Time: 2 Hours**

Course Name: Refrigerant & psychrometry **Max. Marks: 50**

Instruction:

All questions are compulsory.

Section A is objective type.

Section B is short answer type.

Section C is long answer type.

Use psychrometric chart and steam table as per requirement.

Section – A

10X01 = 10 Marks

1. What is the chemical name of R12?
   a) CCl_3F b) C_2H_5F c) CCl_2F_2 d) None
2. What is the chemical name of R21?
   a) $CHCl_2F$ b) C_2H_5F c) CCl_2F_2 d) None
3. What is the mathematical representation for the refrigerant "Methylchloride"?
   a) R12 b) R40 c) R22 d) None
4. What is the mathematical representation for the refrigerant CCl_3F?
   a) R12 b) R40 c) R22 d) None
5. What is the mathematical representation for the refrigerant C_2H_5F?
   a) R134a b) R152 c) R22 d) None
6. Which refrigerant is better in view of GWP?
   a) R134a b) R152 c) CO_2 d) None
7. The rate of body heat loss is affected by-
   a) Air Temperature b) Air humidity
   c) Clothing d) All of the above
8. The relative humidity in winter is ----- than in summer season.
   a) Less b) More
   c) Equal d) All of the above
9. What is the unit of gas constant (R) ?
   a) J/Kg-K b) Kg/K-mol
   c) J/Kg d) None
10. What is the measuring unit of relative humidity?
    a) g/Kg of dry air b) g/m^3 of dry air
    c) J/Kg d) None

Section – B

04X04 = 16 Marks

1. What is a refrigerant? Write down the classification of refrigerants.
2. What is an azeotrope? Give example to indicate its importance.
3. What is the process used for low RH requirement in a room? Describe the same.
4. What is system heat gain? How are they accounted for?

Section – C

04X06 = 24 Marks

1. how is winter air conditioning carried out?
2. explain the concept of RSHF, GSHF and ERSHF.
3. The following data refers to summer air conditioning of a building:

   Outside design condition = 43° C DBT, 27° C WBT

   Inside design condition = 25° C DBT, 50% RH

   RSH = 84 MJ/h, RLH = 21MJ/h, By pass factor = 0.2

The room air from the room is mixed with fresh air before entering the coil in the rate of 4:1 by mass. Determine:

a) Coil ADP.

b) Condition of air entering and leaving the coil.

c) Fresh air cmm.

d) Capacity of the coil in TR.

Sketch the process on psychrometric chart.

4. In an auditorium which is to be maintained at a temperature not exceeding 24° C and a RH not more than 60%, a sensible heat load of 132 kW and 84 kg/h of moisture has to be removed. Air is supplied to the auditorium at 15° C.

   a) How many kg of air per hour must be supplied?

   b) What is the dew point temperature of supply air and is its relative humidity?

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration & Air Conditioning Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, III Semester,

End-Sem. Examination

Course Code: HVA1301 **Time: 2 Hours**

Course Name: Refrigerant & psychrometry **Max. Marks: 50**

Instruction:

All questions are compulsory.

Section A is objective type.

Section B is short answer type.

Section C is long answer type.

Use psychrometric chart and steam table as per requirement.

Section – A

10X01 = 10 Marks

1. What is the chemical name of R12?
   c) CCl_2F_2
2. What is the chemical name of R21?
   a) $CHCl_2F$
3. What is the mathematical representation for the refrigerant "Methylchloride"?
   b) R40
4. What is the mathematical representation for the refrigerant CCl_3F?
   a) R11
3. What is the mathematical representation for the refrigerant C_2H_5F?
   b) R152
6. Which refrigerant is better in view of GWP?
   c) CO_2
7. The rate of body heat loss is affected by-
   d) All of the above
8. The relative humidity in winter is ----- than in summer season.
   a) Less
9. What is the unit of gas constant (R)?
   a) J/Kg-K
10. What is the measuring unit of relative humidity?
    d) None

Section – B

04X04 = 16 Marks

1. What is a refrigerant? Write down the classification of refrigerants.

The working substance that flows through a refrigerator and is capable of absorbing heat from the source (which is at a lower temperature) and dissipate the same to the sink (which is a higher temperature than the source) either in the form of sensible heat (as in case of air refrigeration) or in the form of latent heat (as in the case of vapor Refrigeration) is called a refrigerant.

CLASSIFICATION OF REFRIGERANTS

- Primary refrigerants (Refrigerants that directly take part in the refrigeration process)
- Secondary refrigerants (refrigerants that are first cooled by the primary refrigerants and then further used for cooling purpose

Classification of primary refrigerants

Halocarbon compounds :

(a) invented and developed by Mr. Charles. Kettering and Dr. Thomas Migley in the year 1928.

(b) Sold in the market under the trade name as "Freon" and contain one or more of three halogens chlorine, fluorine and bromine.

Azeotropes :

Consits of mixtures of different refrigerants which don't separate into their compounds with the change in pressure or temperature or both. They have fixed thermodynamic properties.

Azeotropic mixture is a mixture of two or more liquids which, when mixed in precise proportion, form a compound having a boiling temperature which is independent of the boiling temperature of the individual liquids.

Hydrocarbons:

Most of the organic compounds are considered as refrigerant under this group. Most of them possess satisfactory thermodynamic-properties but are highly flammable.

Inorganic compounds:

The refrigerants under this group were universally used for all purposes before the introduction of halo-carbon. refrigerants. Earlier they were used for different purposes due to their inherent thermo-dynamic and physical properties, for example: Unsaturated Organic Compounds : Comprising of mainly hydrocarbon group with ethylene and propylene bases.

2. What is an azeotrope? Give example to indicate its importance.

An azeotrope or a constant boiling point mixture is a mixture of two or more liquids whose proportions cannot be altered or changed by simple distillation.[2] This happens because when an azeotrope is boiled, the vapour has the same proportions of constituents as the unboiled mixture. Because their composition is unchanged by distillation, azeotropes are also called (especially in older texts) constant boiling point mixtures. Many azeotropic mixtures of pairs of compounds are known,[3] and many azeotropes of three or more compounds are also known.[4] In such a case it is not possible to separate the components by fractional distillation. There are two types of azeotropes: minimum boiling azeotrope and maximum boiling

azeotrope. A solution that shows greater positive deviation from Raoult's law forms a minimum boiling azeotrope at a specific composition.

3. What is the process used for low RH requirement in a room? Describe the same.

In our everyday lives the humidity of the air around us very rarely merits discussion unless we are relaxing in a sauna or holidaying near the equator. However, there are not many occasions where humidity is more of an issue than during the processing of textiles. Get it wrong and it can stop production, damage machinery and harm staff. Get it right and you can maximise product weights, improve quality and increase machine speeds. Air humidity is measured as "relative humidity". It is defined as the amount of water in a sample of air compared to the maximum amount of water the air can hold at the same specific temperature. It's expressed in a form of 0 to 100%. Cold air can hold less moisture than warm air therefore the humidity of air is "relative" to its temperature. For example, a sample of air at 10°C can hold less moisture than the same sample of air at 20°C. Even with the same amount of water present in both samples, the warmer sample has a lower relative humidity as it can potentially hold more moisture than the cold air sample. This means that even in humid climates, the indoor air humidity can be low when cool humid air from outside enters a textile production facility and its temperature rises. An increase in temperature of 20°C can lead to a typical drop in humidity of around 60%rH (relative humidity). This means that humid air entering a building at 80%rH would decrease to just 20%rH when heated. This can cause major problems for textile production.

Why humidify?

All textiles are hygroscopic. That is, they absorb or release moisture depending on the relative humidity of the surrounding air. If the atmosphere is drier than the textile's equilibrium relative humidity then the textile will give up its moisture to the air. If the air is very humid then the textile's moisture content will increase. This moisture loss and gain occurs at every stage from the initial processing of the fibres through to final garment manufacturing, distribution and use by the consumer. This change in moisture content has a direct impact on the properties of textiles, such as tensile strength, elasticity, fibre diameter and friction. A drop in the equilibrium relative humidity of a textile may cause it to be weaker, thinner, less elastic and therefore more brittle. It will also have more imperfections. By maintaining the air humidity whilst processing the fibres, this loss in moisture to the atmosphere is minimised. Moisture loss during processing cannot be totally eliminated as the act of processing will increase the temperature of the material, which will cause it to become drier. However, by increasing the humidity of the air surrounding the textile directly after processing, the material experiences "regain". Moisture is reabsorbed by the textile, thus improving the quality and performance of the fabric. This regain also has a direct impact on the weight of the textile. As textile yarns are sold by weight, if a drop in humidity leads to a 4% reduction in weight, this will require 4% more fibre to be included in the sale product. For a mill manufacturing 80 tonnes of textile per day, this can lead to a loss of 3,200kg of product per day due to incorrect humidity control.

Static

The occurrence of static can be a major problem when processing textiles and it is directly related to levels of relative humidity. The electrical sensitivity that determines whether static electrification will occur is dependent on the moisture content of the air and fibres. As the fibres lose moisture, they increase their electrical resistance. This means they can no longer easily dissipate the electrical charge which is generated by the frictional contact with the machinery.

In a textile production facility with a low humidity, static discharges can jump up to 4-5 inches and, although they have a low current, can build up to several hundred thousand volts. This presents a danger to staff working with the machines as it is not only very uncomfortable if they are shocked, but it can cause a person to jump and fall, which presents extreme risks when working near to textile machinery. The static discharge can also present a direct health risk to people with weak hearts or pace makers fitted. As well as the physical danger to staff, static electrical build-up will cause materials to stick together and be less manageable. This in turn will slow machinery, directly effecting production schedules. Also, as most machines are now microprocessor controlled, an uncontrolled electrical discharge in the wrong place can damage the electronics of the unit resulting in expensive repair bills and significant downtime. By maintaining humidity at around 50%rH, static build-up is eliminated and all these associated problems are avoided. Another advantage of maintaining the correct humidity in processing facilities is that it reduces airborne particles. A higher humidity encourages airborne lint, dust and fly to precipitate out of the atmosphere. Also, if a cold water humidification system is used, the evaporation of the water into the air causes an adiabatic cooling effect that can reduce ambient temperatures by between 2-6°C. These additional benefits of using humidifiers create a healthier, less polluted, more pleasant atmosphere for workers and a more productive workforce.

Humidity levels

So what is the ideal humidity? Well this depends on the type of textile and the process being undertaken. Natural fibres are far more susceptible to moisture than manmade, in terms of performance. However manmade textiles suffer more with static charge build up. Cotton and linen have to be processed at very high levels, around 70-80%RH, because they are very brittle. By humidifying each process, from the combing of the raw material, through carding, twisting, spinning and weaving, the manufacturer can ensure that the product remains flexible and is prevented from breaking. This is important since the longer the fibre, the finer the thread that can be spun from it. Wool is similarly susceptible to dry air, although a little more forgiving, requiring humidity levels of around 65%RH. Man-made fibres also require the correct, albeit lower, level of humidity since below 45%RH they are prone to a build-up of static electricity. Silk should be processed at between 65-70%RH, although artificial silk spinning requires a higher level of 85%RH.

4. What is system heat gain? How are they accounted for?

Heat gain refers to the transfer of heat into your home through a variety of sources. The primary source of heat is the sun, and the absorption of heat by your structure increases dramatically during the summer months as solar radiation intensifies. However, your home environment can also gain heat from the operation of appliances, lighting and other fixtures. It's easy to note the impact your oven has on the kitchen during any season. Many people avoid baking during summer months for this reason. Your home comfort system provides a remedy to excess heat, and the more intense the heat gain during the season, the more your equipment works to moderate the temperature in your structure. Preventing your home from gaining too much heat can keep your system from having to work more than necessary. There are several options for limiting the heat transfer into the home during the summer months. Simple steps include installing insulated curtains or solar window screens to reduce the effect

of exterior conditions. You can also use white paint or roof coatings to reflect the sun's rays, reducing solar gain through the walls and roof. You can enhance your home's comfort levels with structural strategies as well. You can add attic insulation to increase the protective barrier that limits heat transfer through the roof. You can also consider the installation of multi-pane windows. Home sealing is important for keeping hot air from infiltrating your home directly. Limiting your use of indoor appliances during the hottest parts of the day can help in reducing your cooling load too. You can leave laundry and baking for evening hours when the sun isn't up and the temperatures are down. Every bit of added heat affects your cooling system's performance, especially during peak temperatures. If you are taking steps to keep your home from gaining heat but still experience poor performance from your air conditioner, then you may benefit from a system tune-up. Many of our customers aren't aware of the fact that their equipment can be optimized to ensure better performance. By checking your equipment thoroughly, we can pinpoint parts that are worn or broken. We also provide some of the following services:

- Coil cleaning – dirty coils keep your refrigerant from doing its job, adding as much as 20 percent to your operating costs
- Refrigerant evaluation – low refrigerant leads to poor cooling ability, increasing your energy usage and costs
- Duct inspection – leaky ducts can allow heat to infiltrate your home, increasing the cooling load and energy usage
- Control and relay checks – faulty electronic equipment can prevent your system from working optimally

Section – C

04X06 = 24 Marks

1. how is winter air conditioning carried out?

Air Conditioning System Winter Air Conditioning System In winter air conditioning, the air is heated which is generally followed by humidification. The schematic arrangement of the system is shown in Fig. The outside air flows through a damper and mixes up with the re-circulated air (which is obtained from the conditioned space). The mixed air passes through a filter to remove dirt, dust and other impurities. The air now passes through a preheat coil in order to prevent the possible freezing of water and to control the evaporation of water in the humidifier. After that, the air is made to pass through a reheat coil to bring the air to the designed dry bulb temperature. Now, the conditioned air is supplied to the conditioned space by a fan. From the conditioned space, a part of the used air is exhausted to the atmosphere by the exhaust fans or ventilators. The remaining part of the used air (Known as re-circulated air) is again conditioned as shown in Fig. The outside air is sucked and made to mix with re-circulated air, in order to make up for the loss of conditioned (or used) air through exhaust fans or ventilation from the conditioned space. Summer Air Conditioning System It is the most important type of air conditioning, in which the air is cooled and

2. explain the concept of RSHF, GSHF and ERSHF.

RSHF

It is defined as the ratio of room sensible heat to room total heat. The supply air having conditions given by any point on this line will satisfy requirements of the room with quantity of air supplied different for different points

RSHF= RSH /RSH+RLH

GSHF

It is defined as ratio of total sensible heat to the grand total heat which the cooling coil is required to handle after the outside fresh air and recirculated air mixing has taken place. GSHF= (Room sensible heat + Outside air sensible heat) ((RSH +ouside air sensible heat)+ (RLH+ outside air latent heat))/(Room sensible heat + Outside air sensible heat)((RSH +ousid e air sensible heat)+(RLH+ outside air latent heat)) The BPF fraction of outside air adds SH load and LH load to the room. However BPF fraction of return air has no effect as it is already at room condition. Thus,

Effective room sensible heat load (ERSH) =RSH+BPF x outside air SH

Effective room latent heat load (ERLH) =RLH+BPF x outside air LH

Hence, ERSHF=ERSH/(ERSH+ERLH)

3. The following data refers to summer air conditioning of a building:

Outside design condition = 43° C DBT, 27° C WBT

Inside design condition = 25° C DBT, 50% RH

RSH = 84 MJ/h, RLH = 21MJ/h, By pass factor = 0.2

The room air from the room is mixed with fresh air before entering the coil in the rate of 4:1 by mass. Determine:

a) Coil ADP.

b) Condition of air entering and leaving the coil.

c) Fresh air cmm.

d) Capacity of the coil in TR.

Sketch the process on psychrometric chart.

Ans:

RSH = 23.23 KW.

RLH = 5.83 KW

RSHF = 0.80

T_3 = 28.6° C

Condition of air entering the coil = 28.6° C DBT and 19.8° C

BPF = 0.2

a. Coil ADP = 10.6° C, T_4 = 14.2° C

b. Air leaving coil = 14.2° C DBT, 12.7° C WBT.

Total air flow = 129.6 Kg/min.

c. Fresh air quantity = 23.83 cmm.

d. Capacity of coil = 12.9 TR.

4. In an auditorium which is to be maintained at a temperature not exceeding 24° C and a RH not more than 60%, a sensible heat load of 132 kW and 84 kg/h of moisture has to be removed. Air is supplied to the auditorium at 15° C.

a) How many kg of air per hour must be supplied?

b) What is the dew point temperature of supply air and is its relative humidity?

Ans: RLCL= 84*2444.9/3600= 57 kw. (hfg at 24° C = 2444.9 KJ/kg)

RSHF = 132/(132+ 57) = 0.6982

RTCL = $m(h_r - h_s)$

a. mass of air per hour that must be supplied m_a = RTCL/$(h_r - h_s)$

189/(52.7-39.7) = 14.54 kg/s

= 52.39X 10^3 kg/h

b. supply air condition is 15° C as given. From psychrometric chart RH = 92%.

DPT is 13.7° C.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration and Air-conditioning

Session: 2019-20 (Summer)

B. Voc. Program, 3rd Semester,

End-Sem. Examination

Course Code: HVA-1302 **Time: 2 Hours**

Course Name: Compressor, Condenser and Evaporator **Max. Marks: 50**

Section – A

10X01 = 10 Marks

1. The evaporator used in household refrigerators is:
   a) Frosting evaporator
   b) Non-frosting evaporator
   c) Defrosting evaporator
   d) None of these
2. The evaporator generally used in home freezers, ice cream cabinets is:
   a) Plate evaporator
   b) Finned evaporator
   c) Shell and tube evaporator
   d) Shell and coil evaporator
3. An evaporator is also known as:
   a) Freezing coil
   b) Cooling coil
   c) Chilling coil
   d) All of these
4. Ball and socket joint used in which type compressor:
   a) Rotary
   b) Reciprocating
   c) Scroll
   d) Screw
5. Which type of cooling tower used without spray nozzles:
   a) Natural draft
   b) Induced draft
   c) Forced draft
   d) Splash deck
6. Which compressor type uses piston to compress the gas?
   a) Scroll
   b) Reciprocating
   c) Screw
   d) Rotary

7. Which compressor type uses tapered, machined gear components to trap the gas for compression?
   a) Scroll
   b) Reciprocating
   c) Screw
   d) Rotary
8. Which style of compressor uses belts to operate the compressor?
   a) Open type
   b) Closed type
   c) Chassis type
   d) Hermetic type
9. Most air cooled condenser are designed to operate with a temperature difference of?
   a) 5° C
   b) 8° C
   c) 14° C
   d) 22° C
10. The natural convection air cooled condensers are used in:
   a) Domestic refrigerator
   b) Water cooler
   c) Room air conditioners
   d) All of these

Section – B

04X04 = 16 Marks

1. Differentiate between positive displacement and roto-dynamics compressor.
2. Differentiate between air cooled and water cooled condenser.
3. Explain construction and working of flooded evaporator
4. Explain function of: a) Accumulator, b) receiver/drier c) oil separator used in air conditioning system

Section – C

04X06 = 24 Marks

1. Explain with neat sketch principle and working of forced draft cooling tower.
2. Explain with neat sketch construction and working of scroll compressor.
3. Differentiate between finned tube and plate evaporator with neat sketch.
4. What is the function of 4-way valve in heat pump? Explain working of 4-way valve with neat sketch

Registration No.: .....

School of Refrigeration and Air-conditioning

Session: 2019-20 (Summer)

B. Voc. Program, 3rd Semester,

End-Sem. Examination

Course Code: HVA-1302 **Time: 2 Hours**

Course Name: Compressor, Condenser and Evaporator **Max. Marks: 50**

Section – A

1. A
2. A
3. D
4. B
5. D
6. B
7. D
8. A
9. C
10. D

Section b

1. **Positive Displacement type:**

Compression is achieved by trapping a refrigerant vapor into an enclosed space and then reducing its volume.
A fixed amount of refrigerant is trapped each time and its pressure raises and its volume is reduced
In positive displacement flow is pulsating/unsteady leads to wear, vibration and noise.

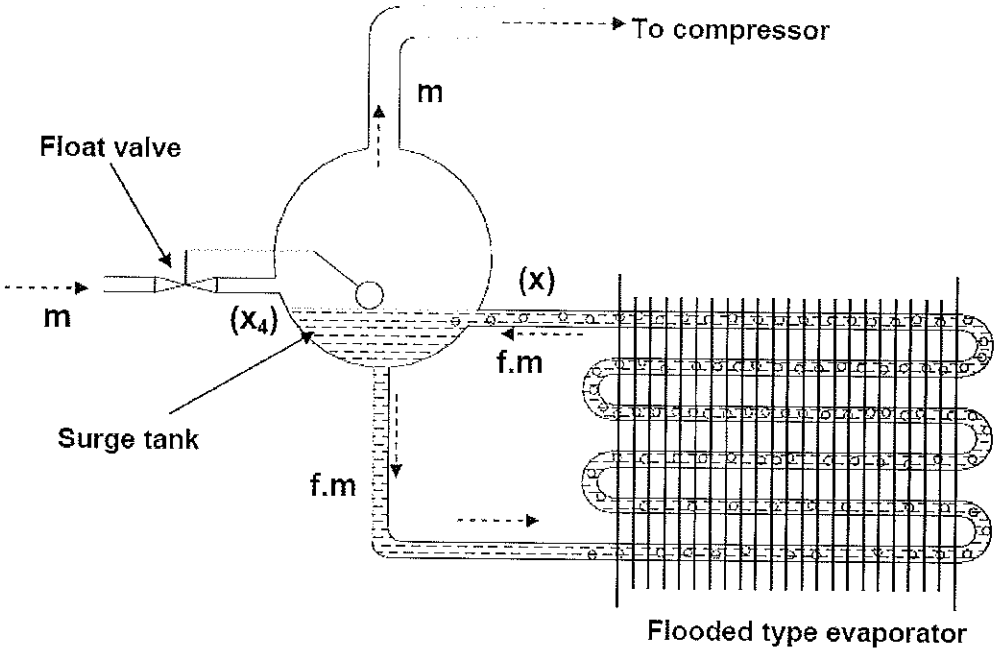
Roto-Dynamics Compressor

The rise in pressure is achieved by imparting kinetic energy (angular momentum) to a refrigerant by a rotating mechanical element (impeller) and then converting the kinetic energy into pressure as refrigerant flow through the diverging passage.
In roto-dynamics flow is not pulsating/steady flow leads to less wear, vibration and noise.

2. Air cooled: construction is very much simple, no handling problem, no corrosion and fouling factor, low heat transfer, low capacity 5TR

water cooled: construction is complicated, difficult to handle, corrosion and fouling are more, large heat transfer and large capacity

3. flooded evaporator:

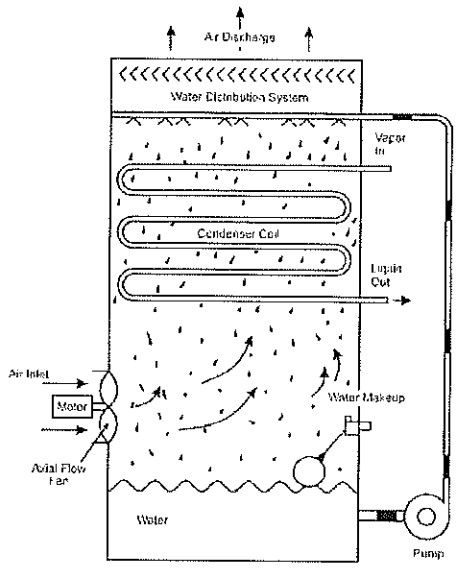


2. The AC accumulator is a holding vessel that receives refrigerant after it leaves the evaporator. Its primary fiction is to cover any remaining liquid refrigerant into its gaseous state before it enters the compressor.

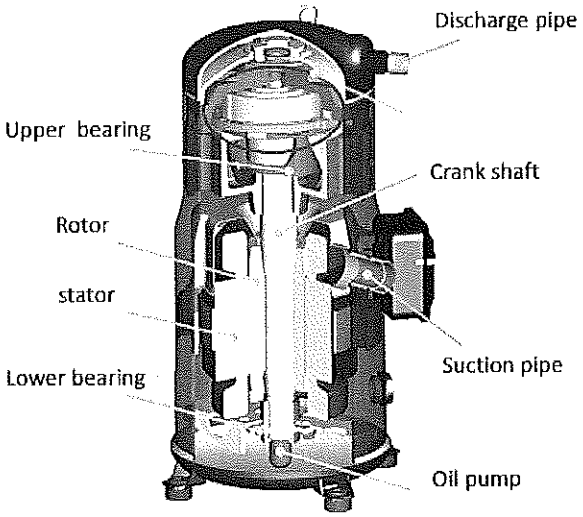
They act as a temporary storage container for oil and refrigerant when neither are needed for system operation (such as during periods of low cooling demand). This is the "receiver" function of the receiver/drier.

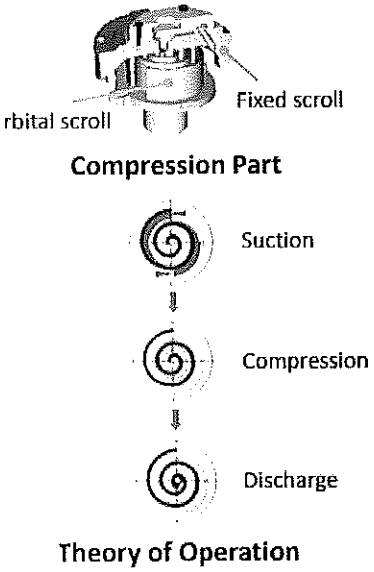
The oil separator is capable of separating oil from the refrigerating gas mixture so as to improve the performance of refrigerating air conditioning system and save energy. It's function enters the inlet of the oil separator from the compressor refrigerant and oil mixture.

Section C forced draft

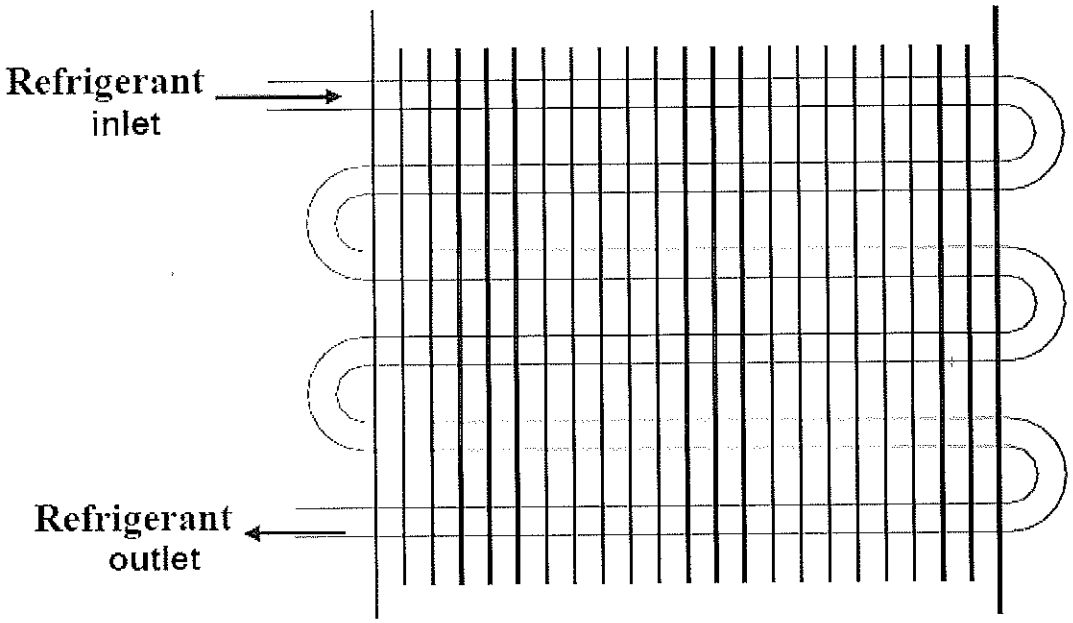


2.


Discharge pipe
Upper bearing
Crank shaft
Rotor
stator
Suction pipe
Lower bearing
Oil pump


rbital scroll
Fixed scroll
Compression Part
Suction
Compression
Discharge
Theory of Operation

3


Refrigerant inlet
Refrigerant outlet

4.

1. discharge connection

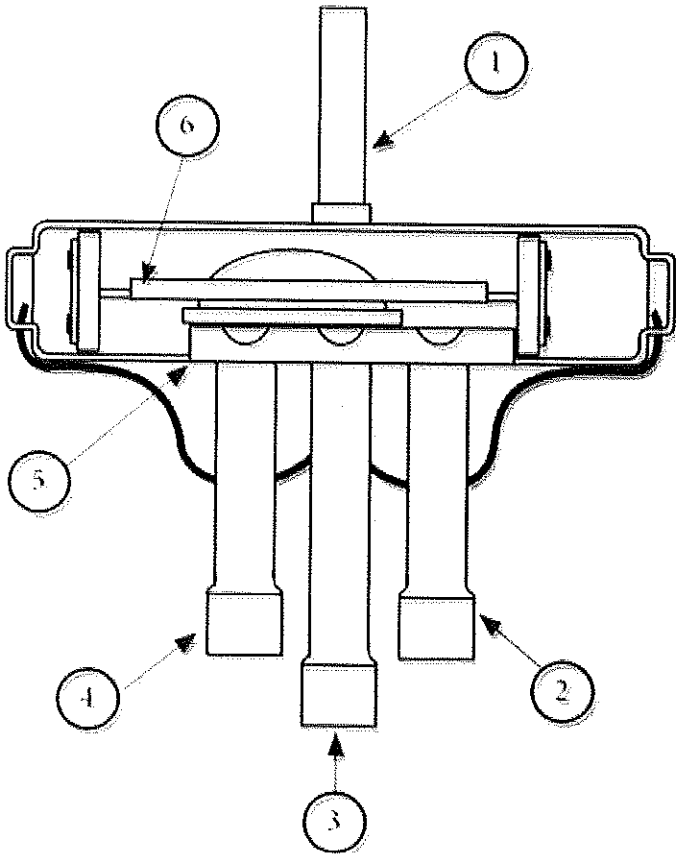
2. connection to evaporator/ condenser

3. suction connection

4. connection to condenser/ evaporator

5. valve body

6. slider



Four-way reversing valves are used to completely reverse the cycle of one-to-one heat pump systems. Such valves may be used to facilitate using the system for both heating and cooling, or to provide an effective and energetically optimized defrosting method.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2019-20 (Summer / Winter Semester)

B. Voc. 3rd Semester,

End-Sem. Examination

Course Code: HVA-1303 **Time: 2 Hours**

Course Name: Air distribution **Max. Marks: 50**

Instruction: Attempt all questions

Section – A

10X01 = 10 Marks

1. Pressure in ductwork is expressed by which of the following units?
   a) Inches of water column
   b) Psig
   c) Psia
   d) Inches of Hg.
2. Warm air heats a room better if distributed
   a) low in the room.
   b) high in the room.
   c) behind the furniture.
   d) under the curtains.
3. Which of the following types of fan is used to move large amounts of air against a low static pressure drop?
   a) Vane axial
   b) Centrifugal
   c) Large
   d) Propeller
4. The duct sizes on the air friction chart are expressed in which of the following?
   a) Square b) Round c)Oval d)Rectangular
5. Zoning an air-conditioning or heating system allows for
   a) temperature control of individual rooms or areas in the space.
   b) simultaneous heating and cooling of individual rooms in a structure.
   c) Neither A nor B is a characteristic of a zoned system.
   d) Both A and B are characteristics of a zoned system.
6. The _____ is frequently used to measure diffusers and slot air flows.
   a) anemometer b) pitot tube c) capture hood d) all of the above.
7. Duct sizing and construction specifications are generally stated in terms of the use of _____.
   a) galvanized steel b) aluminum c) fiberglass reinforced plastic d) none of the above.
8. The perception of comfort relates to which of the following?
   a) individual physical condition
   b) body heat exchange with the surroundings
   c) physiological characteristics
   d) all of the above
9. Air flow above _____ fpm is considered not good for human comfort.
   a) 30 b) 40) c) 60 d) 100
10. The minimum total supply of airflow for residential applications should be :
    a)0.05 cfm/ft2 b) 0.06 cfm/ft2 c)0.6 cfm/ft2 d)10 cfm

Section – B

04X04 = 16 Marks

1. What is indoor air quality?
2. What are some of the materials used in duct construction?
3. Why should all ductwork design should start with accurate heat load study?
4. What are some control devices in an air distribution system?

Section – C

04X06 = 24 Marks

1. What is a distribution system selection criteria?
2. What is zoning? Explain.
3. What are the components of an air distribution system?
4. What are the factors that affect heat exchange ?

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School of RAC Skills

Session: 2019-20 (Summer / Winter Semester)

B. Voc. 3rd Semester,

End-Sem. Examination

Course Code: HVA-1303 **Time: 2 Hours**

Course Name: Air distribution **Max. Marks: 50**

Instruction: Attempt all questions

Section – A

10X01 = 10 Marks

1. a
2. a
3. d
4. b
5. d
6. a
7. a
8. d
9. b
10. b

Section – B

04X04 = 16 Marks

1. **Air contaminants:** - Indoor air contaminants can be solid or liquid particles, gases or vapors. Some can be irritants or odiferous, thus affecting occupant comfort. The same contaminants at higher concentrations, as well as others of which occupants may be unaware, can be health risks.

Outdoor air requirements: - It provides designers with a means of determining ventilation rates needed to achieve acceptable indoor air quality, which is defined as:

"air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the people exposed do not express dissatisfaction."

2.

Material	Applications	Advantages	Limitations
Galvanized Steel	Widely used for most air handling applications. Not recommended for corrosive product handling or temperatures above 200°C.	High strength, rigidity, durability, rust resistance in ordinary conditions, availability, nonporous, workability	Weldability, paintability, weight, corrosion resistance
Carbon Steel (Black Iron)	Breechings, flues, stacks, hoods, other high temperature duct systems, kitchen exhaust systems, ducts requiring paint or special coatings	High strength, rigidity, durability, availability, paintability, weldability, non-porous	Corrosion resistance, weight

3. Right-sizing of a heating, ventilation, and air-conditioning (HVAC) system is the selection of equipment and the design of the air distribution system to meet the accurate predicted heating and cooling loads of the house. The estimated heating and cooling loads are those required to meet the inside design conditions on the design load day. The design load day is not the most extreme weather conditions or the conditions that represent the majority of hours in a year. Temperature swings are expected in the conditioned space during extreme weather, and the system must be able to deliver comfort during the many hours of partial load conditions.

4. A control is a device that regulates a variable such as temperature, velocity or pressure. Controls may be manual or automatic. For example, an air handling unit might have a manually set minimum flow of outside air and an automatic control to increase the outside air as the building becomes more densely occupied. If automatic, the implication is that the control is responsive to a measured change in pressure, temperature or some other variable to be regulated. Two common and important controls are dampers and thermostats. A damper is a device used to vary the volume of air passing through an outlet, inlet or duct. A thermostat is an automatic device that is responsive to temperature.

Section – C

04X06 = 24 Marks

1. **Building characteristics**:-Determine building materials, areas, external surface colors and shapes from building plans and specifications.

Building configuration: Determine building location, orientation and external shading from building plans and specifications. Shading from adjacent buildings should be carefully evaluated as to its probable permanence before including it in the calculation. The possibility of abnormally high ground-reflected solar radiation (for example, from adjacent water, sand or parking lots), or solar load from adjacent reflective buildings should be considered.

Thermal zones:- The thermal zones within the building should be identified. For example, external offices with windows will have different thermal characteristics than windowless rooms in the building' s interior. Additionally, some areas of the building may have to be kept at different temperatures than others.

Building uses.:- The uses to which the building will be put will affect the levels of noise permissible in the building. For example, an office environment is typically less tolerant of noise from the HVAC system than a warehouse.

2. With the outlet devices selected and before duct layout and duct sizing can begin, the designer must determine how many zones of temperature control will be required for both perimeter zones and interior zones. In general, the exterior zone will be divided into zones that will be determined by building exposure (north, east, south or west exposure).

These perimeter zones may be further subdivided into smaller control zones, depending on variations in internal load or a requirement for individual occupant control. Typical situations would include private executive offices, where the owner may want individual control, or areas of high heat gain or loss such as computer rooms, conference rooms or corner rooms with two exposed walls.

Similarly, the interior zones may also be divided into control zones to satisfy individual room requirements or variations created by internal loads, such as lights, people or equipment.

Air Handling Units :- An air-handling unit (AHU) combines fans, coils, filters, dampers, connections to supply and return ducts, and other components into a device that moves air. It may also be used to clean, heat, cool, humidify, dehumidify and mix the air.

Coils

A coil is a cooling or heating element made of pipe or tube. Coils are usually finned, and are found in a number of shapes (serpentine, helical, etc.).

Ducts

A duct is a tube or conduit for conveying air. Ducts are classified in terms of application and pressure. HVAC systems in public assembly, business, educational, general factory and mercantile buildings are usually designed as commercial systems. Air pollution control systems, industrial exhaust systems and systems outside the pressure range of commercial system standards are classified as industrial systems.

4. **Dry bulb/Wet Bulb temperature:** The air dry-bulb temperature is the temperature measured on an ordinary thermometer. Instruments used to measure wet-bulb temperatures are called psychrometers.

Relative Humidity: Relative humidity compares the amount of water in the air to the amount of water the air can hold at a given temperature.

Thermal Radiation: All objects, including human bodies, emit electromagnetic radiation. The wavelength of radiation emitted depends on the temperature of the objects. Such radiation is called thermal radiation.

Air Movement: Air movement may provide desirable cooling in warm conditions, but it may also increase the risk of unacceptably cool drafts.

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Registration No.: .....

School of RAC Skills

Session: 2019-20 (Summer Semester)

B. Voc. 3rd Semester,

End-Sem. Examination

Course Code: 1304 **Time: 2 Hours**

Course Name: Thermal insulation **Max. Marks: 50**

Instruction:

Section – A

10X01 = 10 Marks

1. Formula of critical thickness of insulation through cylindrical wall.

a) k/h

2. Unit of conductive heat transfer is?

c) w/m K

3. What is unit of PERM

c)1 Grain/ hr ft^2 in-Hg

4. Which insulation has lowest working temperature?

b) plastic foams

5. Slag Wool is an example of

a) Mineral Wool

6.Which material has zero coefficient of thermal expansion

c) Calcium Silicate

7. Working range of PUF Insulation I degree centigrade is?

a) 200 to 110

8) Which formula represent heat capacity

a) $Q = m C_p \Delta T$

9. Which Formula represent thermal resistance R?

b) X/ K A

10. Which of following insulation material is non-combustible

b) Mineral wool

1. Write a short note on insulation thickness required to prevent condensation

Answer

$$x = \frac{k}{h_c + h_r}\left(\frac{T_s - T_i}{T_o - T_s}\right)$$

2. Write a short note on heat transfer by conduction and convection.

Answer

Conduction is actually a process which takes place on an atomic-particle level. In metals, thermal conduction results from the motion of free electrons (similar to electrical conduction). In liquids and poorly conducting solids, oscillation of the molecular lattice is thought to be the cause. In gases, conduction occurs through collisions between molecules.

The overall effects of conduction heat transfer can be described on a much larger scale. Experiments have shown that the rate of heat flow is proportional to the temperature difference across an object and the area available for heat to flow through (perpendicular to the direction of heat flow), but inversely proportional to the thickness of the object.

$$Q = k\,A\,T_1 - T_2 \,/\, X$$

Where:

k is material of thermal conductivity, it show how rapid heat can transfer through the an object of unit area and thickness when temperature difference is 1° C. British unit of thermal conductivity is Btu- In/ Ft_2 Hr °F.

Heat transfer through Convection: -

Heat transfer through convection, involves movement of fluid masses.

There are two types of convection Natural and Forced

in Natural difference heat transfer occur when due to temperature difference there is a local density difference that makes pockets of fluid less or more buoyant than the surrounding fluid.

Both Natural and forced convection can be laminar, where heat flow dominated by conduction from the solid boundary, either turbulent where significant eddy mixing occur.

If forced convection is not strong enough then this type of convection is known as mix convection.

The definition of a parameter which can be used to describe the magnitude of convection arises from the fact that the temperature gradient in convection occurs over a thin boundary layer of the fluid,

If the temperature gradient through the thermal boundary layer were uniform (i.e., linear in the plane wall case), the heat transfer from the surface could be defined using the conduction equation, with k being the conductivity of the fluid and x equalling 5T* The gradient is not generally linear, however. In addition, the boundary layer thickness is riot sharply defined, and is known to increase with distance along the surface. For these reasons, convection is characterized using a parameter "h" in place of k/x:

$$Q = h\,A\,(T_s - T_f)$$

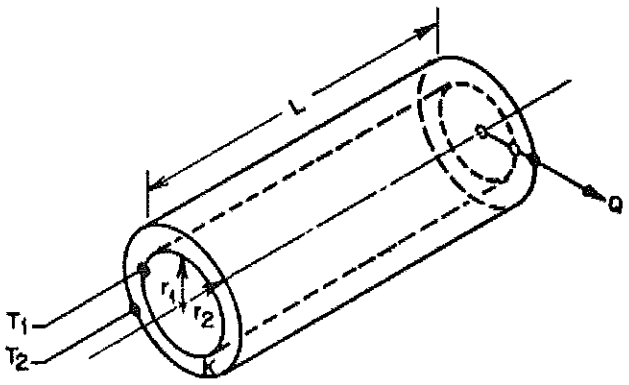
3. **Derive the Equation for heat transfer through cylindrical wall by conduction**

Answer

Heat Transfer through cylindrical wall or radial heat flow

As we know the

$$Q = \frac{2\pi Lk}{\ln(r_2/r_1)}(T_1 - T_2)$$



for solving for thermal resistance from above equation

$$R = \frac{\ln(r_2/r_1)}{2\pi Lk}$$

tbelow equation is represent the total heat flow.

$$Q = \frac{T_1 - T_3}{R_1 + R_2}$$

Putting values in above equation we get

$$\frac{Q}{L} = \frac{2\pi(T_1 - T_3)}{\frac{\ln(r_2/r_1)}{k_1} + \frac{\ln(r_3/r_2)}{k_2}}$$

4. What are R-value and U-value how they are related with C and R values?

Answer

R-Value and U-value: -

R value shows how well a specific material resist the flow of heat. Higher the R-Value higher resistance in heat flow.

R-Value = ΔT x Area x time/ Heat loss = F ft^2 Sec/ Btu

the R-value is the thermal resistance per unit area of a material and is therefore dependent only on the thickness:

R-value = RA = x/k

U- Value is just opposite of R-Value; it is related with thermal conductivity. $W/M^2.K$ is unit of U-value, 1/R- Value is also represent U-value.
$Q = C (T_1 – T_2)$

C = kA / x

Unit of thermal conductance is Btu/ Hr °F

thermal resistance show how well a material resist flow of heat. It is opposite of thermal conductance, it is denoted by "R".

R = 1/C

Section – C

04X06 = 24 Marks

1. A 3 cm diameter pipe at 100 deg C losing heat at the rate of 100W per meter length of pipe to the surrounding air at 20 deg C. This is reduce to a minimum value by providing insulation. Insulation A has quantity of $3.15 \times 10^{-3} m^3$ and k is 5 w/ m-deg, insulation B has quantity of $4 \times 10^{-3} m^3$ and k is 1 w/ m-deg
Insulation A is placed inside insulation B

Answer

R = ΔT /Q

= 100- 20 / 100 = 0.8 deg/W

For a pipe with two layers of insulation materials

$\mathbf{R_{th} = Rt + R_{t1} + R_{t2}}$

$\mathbf{0.8 + 1/ (2 \pi L\ k1)\ log\ r2/ r1 + 1/ (2 \pi L\ k2)\ log\ r3/ r2}$

$\mathbf{r_1 = 0.025\ m}$

$\mathbf{\pi(r^2_3 - r^2_2) / 4 = 4 \times 10^{-3}}$

from this equation r_2 is 0.065 m

$\mathbf{\pi(r^2_3 - r^2_1) / 4 = 3.15 \times 10^{-3}}$

from this equation r_3 is 0.0965 m

after putting the all value in following equation

$\mathbf{R_{th} = Rt + R_{t1} + R_{t2}}$

$\mathbf{0.8 + 1/ (2 \pi L\ k1)\ log\ r2/ r1 + 1/ (2 \pi L\ k2)\ log\ r3/ r2}$

= 0.8 + 0.0467 + 0.0629 = 0.9096 deg/W

2. An oven is maintained at 850°C, wall thickness of walls are 500mm with k 0.4W/m-deg, Find out resistance (R) and heat flow per squire feet for outer temperature of 250°C. Also find temperature at 200mm from interior side

Answer

R = L / k A

= 0.5 / 0.3x 1

=1.25deg/W

Q = T1- T2 / R

=850- 250 /1.25

=480 W

temperature at distance from interior side

t = T1+ {(T2 – T1)/L} X

= 850 +({ 250 – 850) / 0.5} x 0.2

= 610 deg C

3. . Calculate the rate of heat loss through the vertical walls of a furnace of size 4 x 3 x 3 m high. The walls are constructed from an inner fire brick wall 25 cm thick of thermal conductivity 0.4 W/mK, a layer of ceramic blanket insulation of thermal conductivity 0.2 W/mK and 8 cm thick, and a steel protective layer of thermal conductivity 55 W/mK and 2 mm thick. The inside temperature of the fire brick layer was measured at 500°C and the temperature of the outside of the insulation 60 C. Also find the interface temperature of layers

Answer

Given:

Composite Wall l= 4m b= 3m h= 3m

Area of rectangular wall lb = 4x3 = 12m2 L1 = 25 cm

Fire brick k_1 = 0.4 W/mK, L2 =0.002m

Steel k2 = 54 W/mK, L3 = 0.08 m

insulation k_1 = 0.2 W/mK

T1 = 500 C, T2 = 60 C

Find (i) Q (ii) (T3 –T4)

We know that

$Q = \Delta T / R_{th}$

(ΔT) overall = T1 – T4

And ΣR th = Rth1 + Rth2 + Rth3

Rth1 = L1/ k1 A =0.0521K/W

Rth2 L2/ k2 A2 =0.0333K/W

Rth3 = L3/ k3 A =0.0000031K/W 3 ,

Q = Q = $\Delta T / R_{th}$

=500- 60 / 0.0521 + 0.0000031 + 0.0333

= 5152.03 W

(i) To find temperature drop across the steel layer (T3 - T4) , =,

Q = T3- T4/ Rth2

T3- T4 = 5152.03 x 0.0000031

T3- T4 = 0.0159 K

4. A steam pipe of 10 cm ID and 11 cm OD is covered with an insulating substance k = 1 W/mK. The steam temperature is 200 C and ambient temperature is 20 C. If the convective heat transfer coefficient between insulating surface and air is 8 W/m2K, find the critical radius of insulation for this value of r_c. Calculate the heat loss per meter of pipe and the outer surface temperature. Neglect the resistance of the pipe material.

Answer

R_i = 0.05m

R_o = 0.55m

k =1 W/mK

Ti = 300°C To =20°C

h_0 =8 W/m^2K

To find critical radius of insulation

r_c = k/ h_o = 1/8 = 0.125m

if critical radius is outer radius

$$\frac{Q}{L} = \frac{2\pi(T_0 - T_\infty)}{\frac{\ln\left(\frac{r_c}{r_o}\right)}{k} + \frac{1}{h_o r_o}}$$

Q/L = { 2π (300 – 20)} / {ln(0.125/ 0.050) / 1} + (1 / 8 x0.125)

1759/ (0.91+ 1)

= 920 W/ m

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School of RAC Skills

Session: 2019-20 (Summer Semester)

B. Voc. 3 Semester,

End-Sem. Examination

Course Code: HVA1304 **Time: 2 Hours**

Course Name: Thermal Insulation **Max. Marks: 50**

Instruction: (if any)

Section – A

10X01 = 10 Marks

1. Formula of critical thickness of insulation through spherical wall.

a) k/h b) 2k/h

c) h/2k d) h/k

2. Unit of convective heat transfer is?

a) $w/m^2 K$ b) $wm^{2/} K$

c) $w/m K$ d) wm/K

3. What is emissivity?

a) effectiveness of material in emitting energy as thermal conduction.

b) effectiveness in emitting energy as thermal convection.

c) effectiveness in emitting energy as thermal radiation.

d) effectiveness in emitting energy as combined heat transfer.

4. What is unit of perm

a) 1 Grain/ hr ft in-Hg b) 1 Grain hr /ft^2 in

c) 1 Grain/ hr ft^2 in-Hg d) 1 Grain ft^2/ hr in-Hg

5. Which insulation has lowest working temperature?

a) Rock Wool b) Plastic foams

c) Glass wool d) Fiber Glass

6. Slag Wool is an example of ?

a) Mineral Wool b) Cellulosic Insulation

c) Loose insulation d) ceramic fiber

7. Working temperature Range of Cellular Glass Insulation is?

a) 800 °F b) 900 °F

c) 700 °F d) 1000°F

8. Working range of Elastomeric Insulation is

a) 200 to 250 b) 300 – 800

c) 50 – 450 d) 100- 850

9. Cellulose insulation is made of

a) Sand b) Stone wool

c) Slag d) Recycled paper and tree fibers

10. Elastomeric Foam insulation is also known as

a) EPS b) Stone wool

c)XPS d) Expanded rubber foam

Section – B

04X04 = 16 Marks

1. Derive the Equation for heat transfer through plane wall (composite) by conductive heat transfer.
2. Derive the equation for heat transfer through plane wall by combined heat transfer.
3. Write a short note on heat transfer by radiation?
4. What is critical thickness of insulation?

Section – C

04X06 = 24 Marks

1. Calculate insulation thickness (minimum value) required to insulate a hot water tank (plane wall) for inside temperature at 100C. The wall thickness is 1" and the maximum allowable temperature of outer wall of insulation is 25C. Thermal conductivity of the insulation material (glass wool) for the temperature range of the wall can be taken as 0.04 W/m·K. The heat loss from steam per meter of pipe length should not to be more than 80 W/m.

2. An oven is maintained at 850 °C, wall thickness of walls are 500mm with k 0.3W/m-deg, Find out resistance (R) and heat flow per squire feet for outer temperature of 250 °C. Also find temperature at 250mm from interior side.

3. . Calculate the rate of heat loss through the vertical walls of a furnace of size 4 m by 3 m by 3 m high. The walls are constructed from an inner fire brick wall 25 cm thick of thermal conductivity 0.4 W/mK, a layer of ceramic blanket insulation of thermal conductivity 0.2 W/mK and 8 cm thick, and a

steel protective layer of thermal conductivity 55 W/mK and 2 mm thick. The inside temperature of the fire brick layer
was measured at 600 °C and the temperature of the outside of the insulation 60 ^{0}C. Also find the interface temperature of layers

4. A steam pipe of 10 cm ID and 11 cm OD is covered with an insulating substance k = 1 W/m K. The steam temperature is 200 ^{0}C and ambient temperature is 20 ^{0}C. If the convective heat transfer coefficient between insulating surface and air is 8 W/m^{2}K, find the critical radius of insulation for this value of r_c. Calculate the heat loss per meter of pipe and the outer surface temperature. Neglect the resistance of the pipe material.

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School of HVAC & R Skills
Session: 2019-20 (Summer Semester)
B. Voc. Program, 3rd Semester,
End – Semester Examination

Course Code: HVA 1305 **Time: 2 Hours**
Course Name: Electrical and Electronics Safety Testing **Max. Marks: 50**

Instruction: Answer all questions from section A, each question carries one mark. Answer all questions from section B, each question carries four marks. Answer all questions from section C, each question carries six marks. Scientific calculator is allowed.

Section – A

10x01 = 10 Marks

1. Minimum clearance between lines (in meters) when crossing 220 kV and 11 kV lines:
   (a) 4.8 meters (b) 7.94 meters (c) 3.05 meters (d) 2.44 meters

2. Potential transformer secondary should never be:
   (a) Shorted (b) To be kept open (c) both a and b (d) None of these

3. The written intimation of a fatal accident to be reported to the electrical inspector after the occurrence within:
   (a) 48 hours (b) 72 hours (c) 1 week (d) 1 month

4. The earthing resistance of power system should be less than:
   (a) Two ohms (b) Five ohms (c) 10 ohms (d) 20 ohms

5. What should be the minimum clearance in front of the main power panels?
   (a) 0.5 meter (b) 1 meter (c) 2 meters (d) 3 meters

6. _____ glands need to be provided for all outdoor cables terminations.
   (a) Heavy-duty (b) Brass (c) HMI (d) Double Compression

7. Which one of the following methods is used to attached components at PCB?
   (a) The surface mount method (b) The through-hole method
   (c) Both a and b are true (d) None of these

8. PCBs should be fabricated with _____ layers.
   (a) Odd Number (b) Even Number (c) Any Number (d) Two

9. Four 0.15 µF capacitors are in parallel. Which one of the following shows total capacitance?
   (a) 0.15 µF (b) 0.30 µF (c) 0.6 µF (d) 0.8 µF

10. When does the circuit breaker operate in the line?
    (a) When power is to be supplied
    (b) When the line is to be tested
    (c) Whenever the fault occurs in the line
    (d) Whenever the switch and the relay has to be operated

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Section – B

04X04 = 16 Marks

1. What are the benefits of regular visual inspection of electrical equipment?
2. Why the extreme care to be taken when breaking an inductive circuit?
3. Why the secondary circuit of current transformer should be connected to the ground at all times when the transformer is in service?
4. What do you mean by electronic safety? Discuss.

Section – C

04X06 = 24 Marks

1. List the name of items which are being kept in a basic first-aid box?
2. What safety precautions to be taken when you are carrying out the work in existing electrical installation?
3. In new projects which pre-commissioning tests to be carried out.
4. What is relay? Explain the working of relays using suitable diagram.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of HVAC & R Skills
Session: 2019-20 (Summer Semester)
B. Voc. Program, 3rd Semester,
End – Semester Examination

Course Code: HVA 1305 **Time: 2 Hours**
Course Name: Electrical and Electronics Safety Testing **Max. Marks: 50**

Section – A

10x01 = 10 Marks

1. Minimum clearance between lines (in meters) when crossing 220 kV and 11 kV lines:
   (a) 4.8 meters (b) 7.94 meters (c) 3.05 meters (d) 2.44 meters
   Ans. (a)
2. (A) Potential transformer secondary should never be:
   (a) Shorted (b) To be kept open (c) both a and b (d) None of the above
   Ans. (a)
3. The written intimation of a fatal accident to be reported to the electrical inspector after the occurrence within:
   (a) 48 hours (b) 72 hours (c) 1 week (d) 1 month
   Ans. (a)
4. (A) The earthing resistance of power system should be less than:
   (a) Two ohms (b) Five ohms (c) 10 ohms (d) 20 ohms
   Ans. (a)
5. What should be the minimum clearance in front of the main power panels?
   (a) 0.5 meter (b) 1 meter (c) 2 meters (d) 3 meters
   Ans. (a)
6. _____ glands need to be provided for all outdoor cables terminations.
   (a) Heavy-duty (b) Brass (c) HMI (d) Double Compression
   Ans. (d)
7. Which one of the following methods is used to attached components at PCB?
   (a) The surface mount method (b) The through-hole method
   (c) Both a and b are true (d) None of these
   Ans. (c)
8. PCBs should be fabricated with _____ layers.
   (a) Odd Number (b) Even Number (c) Any Number (d) Two
   Ans. (c)
9. Four 0.15 μF capacitors are in parallel. Which one of the following shows total capacitance?
   (a) 0.15 μF (b) 0.30 μF (c) 0.6 μF (d) 0.8 μF
   Ans. (c)
10. When does the circuit breaker operate in the line?
    (a) When power is to be supplied
    (b) When the line is to be tested
    (c) Whenever the fault occurs in the line
    (d) Whenever the switch and the relay has to be operated
    Ans. (c)

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Section – B

04X04 = 16 Marks

1. **What are the benefits of regular visual inspection of electrical equipment?**

Ans. Regular visual inspection of electrical equipment will assist in determining whether it is electrically safe. Visual inspection of electrical equipment may involve, in part:

1. looking for obvious damage, defects or modifications to the electrical equipment, including accessories, connectors, plugs or cord extension sockets, looking for discolouration that may indicate exposure to excessive heat, chemicals or moisture.
2. Checking that flexible cords are effectively anchored to equipment, plugs, connectors and cord extension sockets, looking for damage to flexible cords
3. Checking that operating controls are in good working order i.e. they are secure, aligned and appropriately identified
4. Checking that covers, guards, etc. are secured and working in the manner intended by the manufacturer or supplier
5. Checking that ventilation inlets and exhausts are unobstructed
6. Checking that the current rating of the plug matches the current rating of the associated electrical equipment.

2. **Why the extreme care to be taken when breaking an inductive circuit?**
Ans. The breaking time should be minimum to avoid the continuous persisting of arc. If arc persist for more time it will damage the contacts of the breaker

3. **Why the secondary circuit of current transformer should be connected to the ground at all times when the transformer is in service?**
Ans. If by mistake the secondary of current transformer gets open then there will be high voltage across the secondary winding which can damage the CT as well as can harm human beings. Therefore, we have to ground the secondary of CT.

4. **What do you mean by electronic safety? Discuss.**

Ans. When working with or testing any electronic equipment, it's always important to be cautious. Whatever type of equipment you're handling, whether simple or complex, it's important to take the right safety precautions.
Working with electricity comes with huge risks that should never be taken lightly. If you're a hobbyist who loves working with electronic components or an electronics professional at your workplace, safety should always come first.
To avoid personal injury, possible damage to equipment or danger of fire, all work on electronic equipment should be conducted following these safety procedures.

General Safety

Before working on any electronics, consider following these basic safety precautions to help reduce any hazards.

- Remove any electronic equipment you're testing or working on from the power source.
- Never assume the power circuit is off. Test and test again with a voltmeter to confirm.
- Remove fuses and replace them only after the power to the circuit is disconnected.
- Don't connect power to a circuit until you're done working on it and rechecked the work.
- Always ensure that all electronics equipment is properly grounded
- If it's damaged, replace it. For instance, replace cables instead of repairing with insulating tape.
- Always use the right electronics repair and maintenance tools.
- Always return covers after removing them to reduce the risk of electric shock.
- Make sure your circuit is not overloaded.

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- Always have safety equipment like a fire extinguisher, a basic first aid kit and a mobile phone nearby.

Personal Safety

It's important to ensure that you're safe when working on electronic circuits. Here are some personal safety precautions to keep in mind:

- Always keep your work area dry.
- Always work in a well-ventilated area.
- Don't wear flapping or loose clothing when working.
- Don't work with metallic jewelry on your hands like watches, rings and bracelets.
- Don't use bare hands to remove hot parts.
- Always wear non-conductive shoes.
- Always wear insulator gloves in your hands when carrying out repairs.
- When removing high-voltage charges on capacitors, always use a shorting stick.
- Don't hold the test prods when measuring voltage over 300V.
- Always remove power to a circuit before connecting alligator clips.
- Always wear safety goggles.
- Be careful when handling large capacitors as they can still hold high voltage even after you've disconnected the circuit from power.

High Voltage Safety

One mistake that electronics experts make when doing repairs or maintenance work is assuming routine safety procedures after getting all too familiar with their work. It's important to know that most electronic equipment use high-voltage that is dangerous and can be fatal. Always follow these safety precautions when working on or near high-voltage circuits.

- Don't work on electronic equipment or make repairs with high voltage on.
- Don't take chances doing what you're not sure about.
- Consider using an isolation transformer when working on AC powered electronic circuits or equipment.
- Never tamper with interlocks.
- Don't ground yourself: Make it a practice to use only one hand when connecting equipment to an electronic circuit.
- Never work on a circuit while power is applied.
- Do not connect power to a circuit until the circuit is finished and you have carefully checked your work.
- If you smell anything burning, immediately disconnect the power and examine your circuit to find out what went wrong.
- Keep your work area dry.
- Always wear safety goggles.

Section – C 04X06 = 24 Marks

1. List the name of items which are being kept in a basic first-aid box?

Ans. Your basic first aid kit

A basic first aid kit may contain:

- **plasters in a variety of different sizes and shapes**
- **small, medium and large sterile gauze dressings**
- **at least 2 sterile eye dressings**
- **triangular bandages**
- **crêpe rolled bandages**
- **safety pins**

- **disposable sterile gloves**
- **tweezers**
- **scissors**
- **alcohol-free cleansing wipes**
- **sticky tape**
- **thermometer (preferably digital)**
- **skin rash cream, such as hydrocortisone or calendula**
- **cream or spray to relieve insect bites and stings**
- **antiseptic cream**
- **painkillers such as paracetamol (or infant paracetamol for children), aspirin (not to be given to children under 16), or ibuprofen**
- **cough medicine**
- **antihistamine cream or tablets**
- **distilled water for cleaning wounds**
- **eye wash and eye bath**

It may also be useful to keep a basic first aid manual or instruction booklet with your first aid kit.

Medicines should be checked regularly to make sure they're within their use-by dates.

2. What safety precautions to be taken when you are carrying out the work in existing electrical installation?

Ans. To carry out work in the existing installation requires more attention and precautions to ensure safety. The work can be normal maintenance, repairs or expansion/ upgrading projects. No shortcuts should be taken to save time.

1. In case of such work, permit system or similar system must be established to inform all the stake holders. In case work is to be done in live installation, hot permit should be given to only the trained and authorized technical persons.
2. Use correct drawings
3. Ensure Proper Earthing
4. Disconnect supply to the work area and lock all the handles in 'off' position.
5. Display of proper instruction boards
6. Inform all the stake holders
7. Check all the back feeding possibilities
8. Switch off mode for all switchgears
9. Allow only authorized personnel
10. Avoid working in live installation as far as Possible.
11. Use of proper safety equipment

Once all work is completed; Make sure all the power and control connections are place and are tightened properly. Check disconnected cables in particular.
Remove all the tools, unused material, scrap, nut bolts etc. from the work area particularly from the panels, DB's and transformer cable boxes. May accidents happen due to tools left on bus bars.
Check the earthing connections. Remove the phase neutral earthing if done.
Take all the basic tests required for the installation health check. Do not avoid testing even if the installation was working prior to carrying out the work.

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3. In new projects which pre-commissioning tests to be carried out.

Ans. Pre-commissioning tests as per standards and manufacturers recommendations have to be done to ensure correctness of installation and health of equipment after installation.

These tests help identifying flaws/ problems in the installation if present, that can lead to a faults and consequent accidents, fire during commissioning or operations.

These tests are particularly important for HT equipment and installation and once successful, indicate healthiness of system.
These tests will generally include.

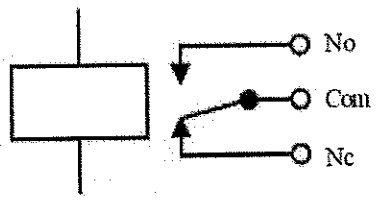
- Insulation resistance for all equipment & cables
- Pressure testing of HT cables
- Earth resistance
- Functional tests including interlocks
- Relay setting & testing
- Phase sequence.
- Continuity of phases, neutral & earth.
- HV test.

It will be advisable if testing of HT installation including relay testing is carried out by independent testing agency.

Do not avoid proper testing to save time. This can lead to much larger time wastage and monetary losses along with increased possibility of fatal accidents.

4. What is relay? Explain the working of relays using suitable diagram.

Ans. **Relay**
Relay is an electrical operated switch consisting of mechanism to make or break the connection in an electric circuit. Relay consists of three components basic coil, armature (level) and yoke. In electromagnetic relay when current passes through coil it generates electromagnetic field that attracts the armature



No : Normal open
Com : Common
NC: Normal Closed

Relay Design

There are only four main parts in a relay. They are

- Electromagnet
- Movable Armature
- Switch point contacts
- Spring

The figures given below show the actual design of a simple relay.

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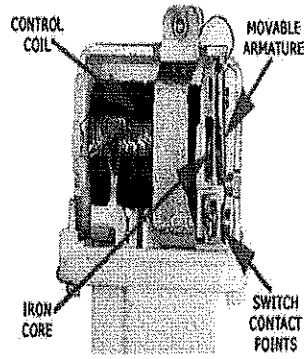
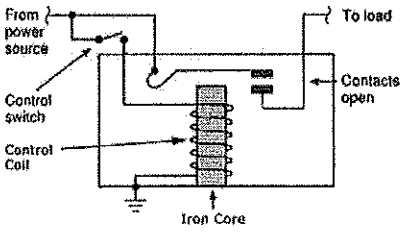


Relay Construction

It is an electro-magnetic relay with a wire coil, surrounded by an iron core. A path of very low reluctance for the magnetic flux is provided for the movable armature and also the switch point contacts. The movable armature is connected to the yoke which is mechanically connected to the switch point contacts. These parts are safely held with the help of a spring. The spring is used so as to produce an air gap in the circuit when the relay becomes de-energized.

How relay works?

The relay function can be better understood by explaining the following diagram given below.



Relay Design

The diagram shows an inner section diagram of a relay. An iron core is surrounded by a control coil. As shown, the power source is given to the electromagnet through a control switch and through contacts to the load. When current starts flowing through the control coil, the electromagnet starts energizing and thus intensifies the magnetic field. Thus the upper contact arm starts to be attracted to the lower fixed arm and thus closes the contacts causing a short circuit for the power to the load. On the other hand, if the relay was already de-energized when the contacts were closed, then the contact move oppositely and make an open circuit.

As soon as the coil current is off, the movable armature will be returned by a force back to its initial position. This force will be almost equal to half the strength of the magnetic force. This force is mainly provided by two factors. They are the spring and also gravity.

Relays are mainly made for two basic operations. One is low voltage application and the other is high voltage. For low voltage applications, more preference will be given to reduce the noise of the whole circuit. For high voltage applications, they are mainly designed to reduce a phenomenon called arcing.