BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 1st Semester,

End-Sem. Examination

Course Code: HVA-1101 **Time: 2 Hours**

Course Name: Basic of RAC **Max. Marks: 50**

Section – A

10X01 = 10 Marks

1. One tonne refrigeration machine means that:
   a) One tonne is the total mass of the machine
   b) One tonne of refrigerant is used
   c) One tonne of water can be converted into ice
   d) One tonne of ice when melts from and at 0°C in 24 hours, the refrigeration effect produced is equivalent to 210 KJ/Min
2. The coefficient of performance is always.....one
   a) Equal to
   b) Less than
   c) Greater than
   d) All of above
3. If the condenser and evaporator temperatures are 312K and 273K respectively, then reversed carnot C.O.P. is:
   a) 5
   b) 7
   c) 9
   d) 10
4. In which phase of a substance does conduction mode of heat transfer take place?
   a) Solid
   b) Liquid
   c) Gas
   d) All of the above
5. The radiant heat emitted by anybody travels at the speed:
   a) less than the speed of light
   b) more than the speed of light
   c) equals to the speed of light
   d) unpredictable
6. At which temperature both degree Celsius and farenhaiet scale are equal:
   a) 100
   b) -40
   c) +40
   d) 0
7. What is the condition for thermodynamic equilibrium?
   a) Thermal equilibrium
   b) Mechanical equilibrium
   c) Chemical equilibrium
   d) All of the above
8. In which direction does heat flow?
   a) From a cold substance to cold substance
   b) Up
   c) Down
   d) From a warm substance to a cold substance

9. Which property remain constant during constant pressure process?
   a) Temperature
   b) Pressure
   c) Volume
   d) Enthalpy
10. Different modes of heat transfer are:

a) Conduction
b) Convection
c) Radiation
d) All of above

Section – B

04X04 = 16 Marks

1. What is thermodynamics system? Write down different types of thermodynamics system.
2. Derive the mathematical equation for viscosity. Differentiate between the psudoplastic fluid and dilatent fluid on the basis of viscosity
3. Differentiate between forced convection and free convection heat transfer used in RAC system with examples
4. What is heat exchanger? Write different types of heat exchanger used in RAC system.

Section – C

04X06 = 24 Marks

1. What is pressure? Write down different pressure units used in RAC. Explain with neat sketch absolute pressure, gauge pressure, and vacuum pressure.
2. Derive expression for steady flow energy equation.
3. Differentiate between heat engine, heat pump and refrigeration with neat sketch.
4. A 10 cm copper ball is to be heated from 100°C to an average temperature of 150° C in 30 minutes. Taking the average density and specific heat of copper in this temperature range is ρ= 8950 kg/m^3 and Cp = 0.395 KJ/kg°C respectively. Determine
   a) The total amount of heat transfers to the copper ball, b) the average rate of heat transfer to the ball, and c) the average heat flux. Consider volume of spherical ball to be 0.000523 m^3

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of RAC Skills

1st Semester, End Sem. Examination

B. Voc. Program, Summer Semester (2019-20)

Course Code: HVA-1101 **Time: 1 Hour**

Course Name: Basic of Refrigeration and Air-Conditioning **Max. Marks: 20**

Instruction: (Attempt all questions.)

Section A

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

Short answer: Section B

1) Thermodynamics system is defined as quantity of matter or region in space upon our attention is to be considered for analysis of problem.
   Types of system are: open system, close system and isolated system
2) T= Udu/dy
   Psudoplastic when the deformation is given shear stress increase.
   Dilatant: when the deformation is given shear stress decrease.

3) Free convection: in which heat transfer due to density difference.
   Forced convection: in which heat transfer due to fun. Blower etc.

4. heat exchanger types of heat exchanger are: air cooled, water cooled and evaporative cooling

Long answer question Section C

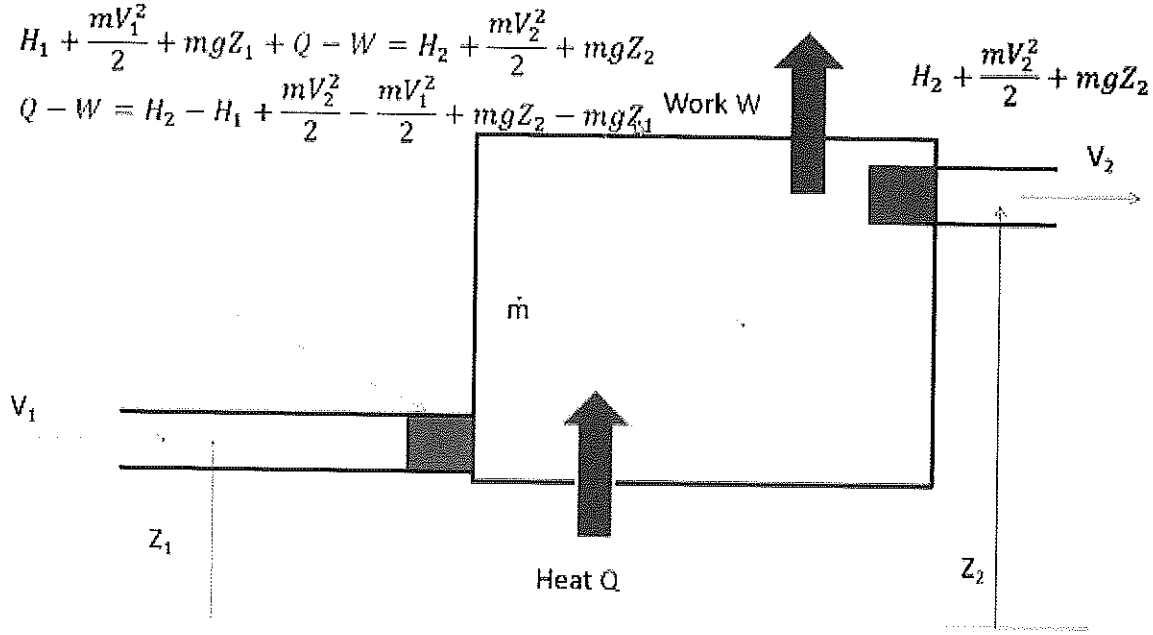
1) Pressure: it is a normal force/unit area
   Different pressure units are: N/m2, Pascal, Bar, atmospheric pressure, torr, PSI, mm of Hg.
   Absolute pressure = atmospheric pressure+ gauge pressure (pressure above atmospheric)
   Absolute pressure = atmospheric pressure- gauge pressure (pressure below atmospheric)

2).

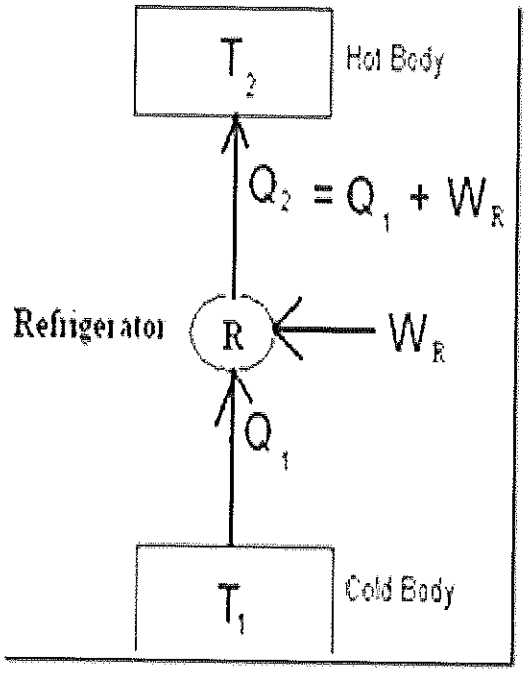
Steady Flow Energy Equation

$$H_1 + \frac{mV_1^2}{2} + mgZ_1 + Q - W = H_2 + \frac{mV_2^2}{2} + mgZ_2$$

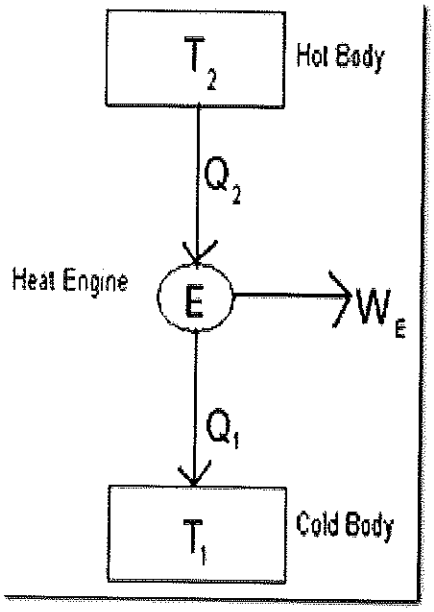
$$Q - W = H_2 - H_1 + \frac{mV_2^2}{2} - \frac{mV_1^2}{2} + mgZ_2 - mgZ_1$$



$$H_1 + \frac{mV_1^2}{2} + mgZ_1 + Q - W$$



$T_1 < T_2$



$T_1 > T_2$

3).

4. q= mCp dt

m=ρ*V= 4.686 Kg

Q= 92.6 KJ

Q av. = 92.6/1800 0.0514 Kj/s= 51.4 W

Qavg= q/A 1636W/m^2

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of RAC Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 1st Semester,

End-Sem. Examination

Course Code: HVA1102 **Time: 2 Hours**

Course Name: Installation and Assembly of Refrigerator **Max. Marks: 50**

Instruction:

Section – A

10X01 = 10 Marks

1. Which oil is suitable for R134a?
   a) POE
   b) Mineral oil
   c) Glycols
   d) PAE

2. What is main function of accumulator?
   a) Separate oil from suction refrigerant
   b) Separate vapour and liquid at suction
   c) Separate oil from discharged refrigerant
   d) Separate vapour and liquid at discharge

3. What is main purpose of vacuuming
   a) Evacuate moisture
   b) Evacuate Refrigerant
   c) Store Refrigerant in outdoor
   d) Evacuate oil

4. What is sign of over-charged system?
   a) Very High temperature at evaporator
   b) Very High temperature at expansion valve
   c) Very High temperature at condenser
   d) Very High temperature at compressor

5. Which type of condenser is common in direct cool refrigerators?
   a) Fin and tube
   b) Shell and tube
   c) Wire and Tube
   d) Tube in tube

6. Which type of copper-grade can't be used for refrigeration

a) K

b) L

c) M

d) DWG

7. Which refrigerant is highly flammable?

a) R32

b) R134a

c) R600

d) R410A

8. What is purpose of capacitor in compressor wiring?

a) Providing Starting torque

b) Delay in compressor starting

c) Soft start of motor

d) Speed control of motor

9. What is full from of PTC ?

a) Positive temperature coefficient

b) Positive temperature capacitor

c) Positive terminal connection

d) Passive temperature coefficient

10. What is main purpose of current relay?

a) control overheating of compressor

b) protection against high current

c) protection against high voltage

d) control of fluctuating power supply

Section – B

04X04 = 16 Marks

1. Explain Refrigerant charging Process for R134a, with suitable diagram.
2. Explain working of potential relay with suitable sketch.
3. What are types of thermostat, explain with diagram?
4. What are different components of water cooler and how they work?

Section – C

04X06 = 24 Marks

1. What are basic safety precautions while servicing a water cooler.
2. What are basic troubleshooting steps when a water cooler is not cooling, explain in details?
3. How does Water cooler work, explain in details?
4. How to identify faulty compressor and replace it?

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

(B)

Registration No.: .....

School of RAC Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 1st Semester,

End-Sem. Examination

Course Code: HVA1102 Time: 2 Hours

Course Name: Installation and Assembly of Refrigerator Max. Marks: 50

Instruction:

Answer key 1

Section – A

10X01 = 10 Marks

1. Which oil is suitable for R134a

   a) POE

2. What is main function of accumulator

   b) Separate vapour and liquid at suction

3. What is main purpose of vacuuming

   a) To evacuate moisture

4. What is sign of over-charged system

   c) Very High temperature at condenser

5. Which type of condenser is common in direct cool refrigerator

   c) Wire and Tube

6. Which type of copper-grade can't be used for refrigeration

   d) DWG

7. Which refrigerant is highly flammable?

   c) R600

8. What is purpose of capacitor in compressor wiring?

   a) Providing Starting torque

9. What is full from of PTC ?

   a) Positive temperature coefficient

10. What is main purpose of current relay?

    b) protection against high current

Section – B

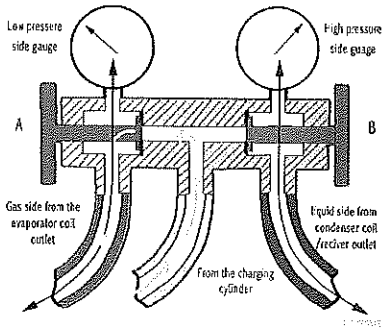
04X04 = 16 Marks

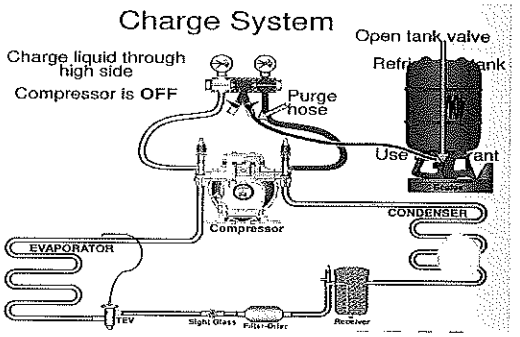
1. Explain Refrigerant charging Process for R134a, with suitable diagram.

   Answer

Non or very less flammable Refrigerant Charging Procedure:-

- Ensure Vacuuming before charging the system
- Purge the high and low side of system Open.
- Now tight both the low and high-pressure side hose.
- Start charging the gas refrigerant from the refrigerant bottle to the low-pressure side of the HVAC system at connection C by opening the valve A and the refrigerant valve of the charging bottle until the vacuum comes to zero.
- Now start the compressor as the suction pressure goes above zero.
- After about 30 – 40 seconds of charging close the valve A and check the suction gauge pressure for a rise in pressure.
- Keep monitoring the degree of superheat by the temperature calibrator to ensure liquid is not entering into compressor suction also we can calculate how much charge present in the system by the pressure chart.
- If the superheat temperature is high, then it means the system is running low in refrigerant whereas lower superheat temperature than the desired value means the system has overcharged.
- Repeat the procedure 10 to 11 until the suction pressure reaches to 60 psi (as per maker) this avoids the risk of overcharging of the system also keep measuring the refrigerant by the weighing scale.
- Once the refrigerant has charged, close the refrigerant valve, valve A and B and disconnect all the hoses and secure everything.

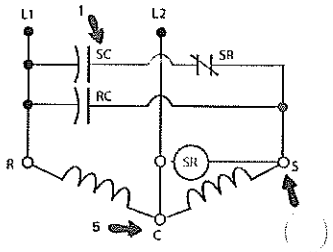




2. Explain working of potential relay with suitable sketch.

Answer

- The SC and RC are wired in parallel, increasing the capacitance at start-up and providing the torque when power is first applied.
- The high resistance coil of the potential relay operates on counter electromotive force (CEMF) generated in the start winding.
- During the start-up period the CEMF is insufficient to operate the relay.
- The CEMF generated across the start winding causes a small current to flow in the start winding and through the potential relay coil.



- Once the compressor motor reaches 75-80% of its full load speed the CEMF (back voltage) is high enough to energize the coil of the potential relay, opening up the contact between terminals 1 and 2.
- When terminals 1 and 2 are open, the start capacitor is no longer in the circuit and the compressor is now operating as a permanent split capacitance (PSC) motor.
- When the power is removed and the compressor rotation begins to decrease, so does the CEMF.
- Once the potential relay no longer has enough voltage to hold the contacts open and the contacts between terminal 1 and 2 return to their normally closed position by spring power.

3. What are types of thermostat, explain with diagram?

Answer

Thermostats work on the principle of thermal expansion that switching off or on of the electric circuit. The most common types of mechanical thermostats typically use either bimetallic strips or bellows filled with gas. While digital thermostats use the same principle, but everything is controlled by a chip and built-in minicomputer.

Bimetallic Strips: As the name indicates, this thermostat has two pieces of metals, which have varying coefficients of expansion, but are connected to each other with the help of bolts to form a bimetallic strip. This strip works like a bridge to connect or disconnect the electric circuit of the heating or cooling system. When the bridge is down, the circuit gets completed, causing the heating or cooling to come on. However, with time, the strip gets hot, causing one of the metal pieces to get hotter than the other. The hotter strip expands, causing it curve and bend. This, in turn, breaks the circuit, the heating or cooling switches off.

It can adjust the temperature using a thermostat to change when the electric circuit of the heating or cooling unit completes or breaks off. The rate at which the metal in the bimetallic strip cools is dependent on how well your home is insulated. In typical cases, it takes about an hour or so for the bimetallic strip to cool down and the thermostat to switch on.

Bellows with Gas: One of the problems with bimetallic strip is that it takes a while to heat and cool. Hence, when you require the temperature to change quickly, it will not happen. This is where bellows with gas and two metal discs come in. The metal discs have a wide surface area, allowing them to quickly heat. So, when an electric current passes through the circuit, the gas in the bellows heats and the bellows expand. This causes the two metal discs to separate, and the disc that is posterior in position is pushed towards a tiny switch located at the center of the thermostat. This immediately interrupts the circuit, causing the heating or cooling to switch off. Then the gas in the bellows starts cooling down, causing the bellows to contract. This forces the metal discs back together, resulting in the inner disc moving away from the tiny switch. So, the circuit gets completed and the HVAC unit turns on again.

4. What are different components of water cooler and how they work?

   Answer

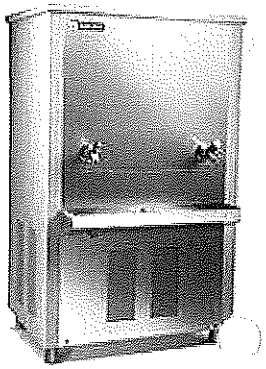
   These are components of Water Cooler

   - Metallic body
   - Compressor
   - Condenser
   - Cooling Coil
   - Expansion Valve

- Thermostat
- Electrical Connections
- Drain Tray
- Water tank etc.

Working of Water Cooler

First of all water has filled into water tank, then we have to start cooling system. Cooling coil has indirect contact with water, chilled refrigerant flow through cooling coil exchange heat with water and cools it. Heat of water is rejected by condenser in environment by help of fan motor.



According to the requirement we can set cooling temperature of water by adjusting of thermostat.

Drain tray helps to drain out waste water from water outlet taps.

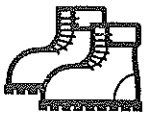
Outer body of water cooler is metallic after it there is a insulation layer that prevent heat exchange between cold water and atmosphere. This whole assembly is mounted on a metallic stand.

Section – C

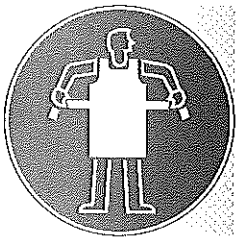
04X06 = 24 Marks

1. **What are basic safety procedures while servicing a water cooler.**

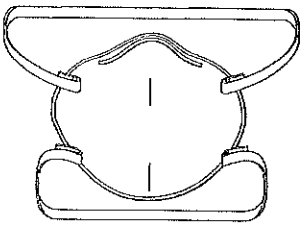
Always wear PPEs , the list of PPEs is below



- Safety shoes:
- Safety Gloves
- Safety Nose Mask
- Apron etc



- Do not plug several appliances into the same sockets.
- Do not directly spray water inside or outside the fridge
- Do not insert the power plug with wet hands..
- Pull the power plug out of the socket before replacing the interior light in the refrigerator.
- Be sure to earth the appliance.
- Always use right tool it save time and efforts



- Don't tilt compressor it, compressor oil will come outside.
- Don't allow kids around you while working
- Handle refrigerant with extra care

- Some refrigerant are flammable, always use fire safety while handling these kind of refrigerants.
- If there is need to release refrigerant into atmosphere, release it slowly in open space not inside a room.

2. **What are basic troubleshooting steps when a water cooler is not cooling, explain in details?**

Basic steps of trouble shooting of a water cooler when its not working are as follows

Check its condition (visual inspection)

if water is in ON condition means cooling system component are working then

check weather compressor is Ground or not

Condenser is hot or not if condenser is not hot means there is less refrigerant in the system or system is chock

check for chock circuit first

if circuit is not chock then check the leak in system, find the leak and remove it. After it vacuum the circuit and charge the refrigerant.

If system in not in ON condition

Check its electrical connections, if there is open circuit, short is by taking required safety procedures

then check condition of relay and capacitor, replace them if they are faulty.

Now check for thermostat, if thermostat is not working replace it.

If after this all system is not working most probably compressor is dead, replace the compressor.

These are basic steps to find faults in water cooler, these steps include many basic operations like

Vacuuming

Refrigerant charging

Leak finding

Brazing etc.

All these operations must perform in a right manner with safety.

3. **How does Water cooler work, explain in details?**

Water cooler in very common domestic RAC machine. Working of water is discribed follows

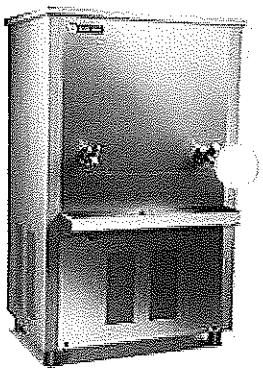
Componests of water cooler

- Compressor
- Cooling coil
- Condenser
- Capillary

- Water tank
- Metallic stand
- Insulation
- Water tray
- Ball Valve
- Thermostats
- Water outlet taps

Working

First of all water has filled into water tank, then we have to start cooling system. Cooling coil has indirect contact with water, chilled refrigerant flow through cooling coil exchange heat with water and cools it. Heat of water is rejected by condenser in environment by help of fan motor.



According to the requirement we can set cooling temperature of water by adjusting of thermostat.

Drain tray helps to drain out waste water from water outlet taps.

Outer body of water cooler is metallic after it there is a insulation layer that prevent heat exchange between cold water and atmosphere. This whole assembly is mounted on a metallic stand.

Ball valve control amount of water inside water tank it automatically when water tank is full of water.

There are many other ports for cleaning of water tank, overflow tank and water outlet ports.

4. **How to identify faulty compressor and replace it?**

In order to identify fault inside a compressor, first of all we have to check all other electrical equipment, because replacing other equipment is comparative easy.

We must check these components first

- Relay
- Capacitor
- Thermostat
- Wiring
- OLP
- Electrical contactor

Follow basic instruction and check above components first, if these components are working fine then check compressor.

One of basic operation to check fault in compressor is as follows

Take a multimeter

Set in on continuity mode

Now on compressor power supply

now touch a probe of multimeter on compressor and another with water cooler body if there is continuity that means compressor winding d are short and we have to replace the compressor.

If there is no continuity in this there are still chances that compressor is still faulty.

If every other component is working fine but we are not getting cooling that indicate that compressor is not faulty even compressor in in running condition, it may happen due to internal damage in compressor.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration & Air Conditioning Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, I Semester,

End-Sem. Examination

Course Code: HVA1103 **Time: 2 Hours**

Course Name: AC Installation & Assembly **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.

Section – A

10X01 = 10 Marks

1. In which refrigeration system compressor is used?
   a) VCRS b) VARS c) Both d) None
2. What is the measuring unit of electric current is?
   a) Volt b) Ampere c) Ohm d) None
3. The resulting temperature of an AC is ----- than a refrigerator.
   a) More b) Less c) Equal d) None
4. What is the measuring unit power?
   a) Watt b) Kelvin c) Bar d) None
5. For measuring the outer dimension of an object, which jaws of Vernier caliper are used?
   a) Internal Jaws b) External Jaws
   c) Both d) None
6. The heat exchanger fins are made up of--.
   a) Aluminium b) Copper c) Steel d) None
7. What is the condition of refrigerant at the exit of compressor?
   a) Vapour b) Liquid
   c) Mixture d) None
8. What is the condition of refrigerant at the exit of condenser?
   a) Vapour b) Liquid
   c) Mixture d) None
9. What is the condition of refrigerant at the exit of evaporator?
   a) Vapour b) Liquid
   c) Mixture d) None
10. Star rating of AC is decided by--.
    a) BEE b) Manufacturer
    c) Both d) None

Section – B

04X04 = 16 Marks

1. What is a compressor and how does it work in a refrigeration system?
2. What is an accumulator
3. What is a heat exchanger and how do differentiate condenser from evaporator?
4. Convert the following:

   a) 2 TR = -- HP b) 3 TR = -- KW c) 2 TR = -- BTU d) 2.5 HP = -- BTU

   e) 24000 BTU = -- KW f) 2.1 Kg = -- gm g) 1.5 mm = ---- Micron

   h) 70 Micron = --- mm

Section – C

04X06 = 24 Marks

1. Explain different type of compressors in detail.
2. Write a note on "Importance of safety".
3. Explain the Micrometer with neat sketch in detail.
4. Write down the vacuuming process in detail.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

School of Refrigeration & Air Conditioning Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, I Semester,

End-Sem. Examination

ANSWER KEY

Course Code: HVA1103 **Time: 2 Hours**

Course Name: AC Installation & Assembly **Max. Marks: 50**

Instruction:

All questions are compulsory.

Section A is objective type.

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Section – A

10X01 = 10 Marks

1. In which refrigeration system compressor is used?
   a) VCRS
2. What is the measuring unit of electric current is?
   b) Ampere
2. The resulting temperature of an AC is ----- than a refrigerator.
   a) More
3. What is the measuring unit power?
   a) Watt
4. For measuring the outer dimension of an object, which jaws of Vernier caliper are used?
   b) External Jaws
6. The heat exchanger fins are made up of--.
   a) Aluminium
7. What is the condition of refrigerant at the exit of compressor?
   a) Vapour
8. What is the condition of refrigerant at the exit of condenser?
   b) Liquid
9. What is the condition of refrigerant at the exit of evaporator?
   c) Mixture
10. Star rating of AC is decided by--.
    a) BEE

Section – B

04X04 = 16 Marks

1. What is a compressor and how does it work in a refrigeration system?

Ans:

A compressor is the most important and often the costliest component (typically 30 to 40 percent of total cost) of any vapour compression refrigeration system (VCRS). The function of a compressor in a VCRS is to continuously draw the refrigerant vapour from the evaporator and then to raise the pressure of the refrigerant. An air conditioner compressor is the component in the system that raises the temperature and pressure of the vapor refrigerant that leaves the evaporator coil. Its important that the compressor raises the pressure of the vapor refrigerant so that it creates a pressure difference, the pressure difference is needed in order for the refrigerant to flow. High pressure fluids flow towards lower pressure fluid. Basically what happening is the compressor is raising the pressure of the refrigerant so that the refrigerant will flow to the lower pressure refrigerant in the evaporator coil.

2. What is an accumulator

An AC accumulator is used to collect and store any liquid refrigerant that may flow out of the evaporator coil. Since liquids cannot be compressed, it's critical that only refrigerant gas enters the AC compressor. The accumulator allows only a regulated amount of refrigerant oil and refrigerant gas to enter the AC compressor. As liquid refrigerant and oil enter the accumulator inlet, they hit a baffle near the top that distributes the oil and liquid to the sides of the accumulator, where it falls to the bottom. A U-shaped tube is attached to the outlet of the accumulator. The inlet to the U-shaped tube is located near the top of the accumulator so it can't suck any liquid refrigerant into the compressor. The tube contains an oil suction hole at the base.

3. What is a heat exchanger and how do you differentiate condenser from evaporator?

Ans:

A heat exchanger is a system used to transfer heat between two or more fluids. Heat exchangers are used in both cooling and heating processes. The fluids may be separated by a solid wall to prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power stations, chemical plants, petrochemical plants, petroleum refineries, natural-gas processing, and sewage treatment. The classic example of a heat exchanger is found in an internal combustion

engine in which a circulating fluid known as engine coolant flows through radiator coils and air flows past the coils, which cools the coolant and heats the incoming air. Another example is the heat sink, which is a

passive heat exchanger that transfers the heat generated by an electronic or a mechanical device to a fluid medium, often air or a liquid coolant

4. Convert the following:

a) 2 TR = 2.5 HP b) 3 TR = 10.5 KW c) 2 TR = 24000 BTU d) 2.5 HP = 24000 BTU

e) 24000 BTU = 7 KW f) 2.1 Kg = 2100 gm g) 1.5 mm = 1500 Micron

h) 70 Micron = 0.07 mm

Section – C

04X06 = 24 Marks

1. Explain different type of compressors in detail.

Reciprocating Compressor

The reciprocating compressor is the most popular type of AC compressor. A piston compresses the air by moving up and down inside of a cylinder. As the piston moves down, it creates a vacuum effect that sucks in the refrigerant. As it moves up, the gas compresses and moves into the condenser. A reciprocating air conditioning compressor is very efficient, as AC units can have up to eight cylinders within the compressor.

Scroll AC Compressor

Scroll air conditioning compressors. They contain one fixed coil—called the scroll—in the centre of the unit, and then there is another coil that rotates around it. During this process, the second scroll pushes the refrigerant towards the centre and compresses it. Scroll compressors are quickly becoming as popular as reciprocating compressors because they do not have as many moving parts and are therefore more reliable.

Rotary Air Conditioning Compressor

Rotary compressors are small and quiet, so they are popular in locations where noise is a concern. The inside of this type of AC compressor contains a shaft with several blades attached to it. The bladed shaft rotates inside the graduated cylinder, consequently pushing the refrigerant through the cylinder and compressing it simultaneously.

Centrifugal Air Conditioning Compressor

The final type of AC compressor is the centrifugal compressor. As the name implies, it uses centrifugal force to pull in the refrigerant gas and then spins it rapidly with an impeller to compress it. Centrifugal air conditioning compressors are usually reserved for extra large HVAC systems.

Screw AC Compressor

The screw compressor is extremely reliable and efficient, but it is mainly used in large buildings where there is a vast amount of air that requires continuous cooling. A screw air conditioning compressor contains two large helical rotors that move the air from one end to the other. As the refrigerant moves through the compressor, the space gets smaller, and it gets compressed.

2. Write a note on "Importance of safety".

Ans:

Working as an HVAC technician in the field of heating, cooling, and air can be a rewarding career choice. The opportunity to actively problem solve while enjoying a stable salary, the field of HVAC certainly has its advantages. However, while working in heating, cooling and air offers numerous benefits, that doesn't mean there are not precautions as well and whether you've been working in this field for a few months or a few years, you will want to know these 5 important safety tips.

1.) Make Protection a Priority

The most effective way to stay safe while on the job? Make protection a priority. Anytime you are being exposed to contaminants such as dust or other debris, you will need protective equipment like a respirator to avoid inhaling these harmful substances. In addition, you'll also want to make sure to wear goggles or some type of face shield to keep your eyes safe from harmful exposure. Gloves should also be worn when handling particles and anything that has the potential to cut you. Remember, safety starts with protection first

2.) Assess the Situation at Hand

In addition to using protective equipment to ensure your safety, you will also want to assess the situation at hand. Before jumping into a task, take the time to identify any potential hazards that may be present on the job site. Each job is a unique situation and location, so it's wise to take the necessary safety precautions beforehand. While it can be tempting to immediately start on a job, it's better to take the time to get the job done and do it right than to just rush through everything.

3.) Double-Check Your Equipment

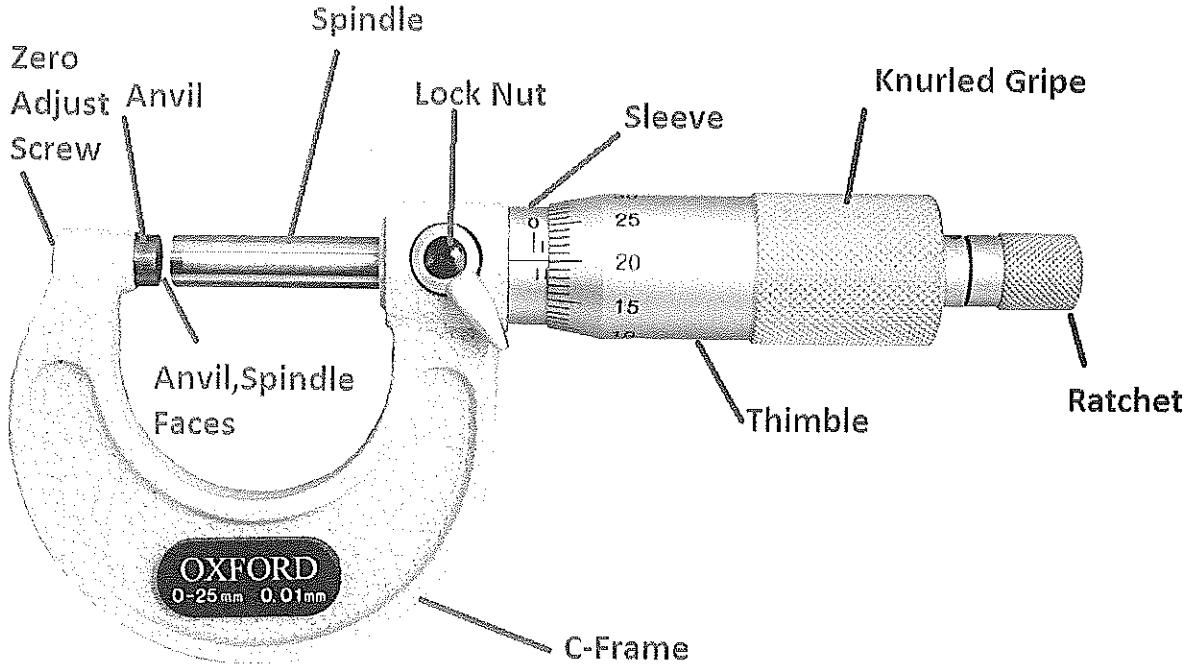
Moving from one job site to the next is a common scenario for many HVAC technicians. So having the right tools for the job is crucial when it comes to heating and air. Before starting a job, assess the required tools you will need in order to complete the job. Whether a wrench, wire strippers, or even a vacuum gauge it's important to always double-check your equipment. Keeping everything in order is important for completing the task at hand while also keeping you safe in the process. Using faulty equipment is more likely to lead to injury so performing routine maintenance is key.

4.) Don't Take Shortcuts

In addition to double-checking your equipment, you will also want to make sure you're not taking any shortcuts. As an HVAC technician, you're working with chemicals, electricity and in some cases extreme temperatures on a regular basis. And while taking a shortcut might save you a few seconds, exercising caution should be your number one priority. In order to truly be safe on the job, technicians must follow procedure.

5.) Exercise Caution Around Chemicals While HVAC technicians face a number of potential hazards while on the job, caution must especially be adhered to when it comes to chemicals. With the potential to cause bodily harm, chemicals need to be stored and handled properly in order to prevent serious damage.

3. Explain the Micrometer with neat sketch in detail.



Micrometer Parts

4. Write down the vacuuming process in detail.

STEP 1: LOCATING HIGH AND LOW SIDE SERVICE PORTS

Park the vehicle on a level surface with the engine off. Apply the emergency brake with the transmission in park and wear protective eye wear and gloves. After replacing a failed component the system is "flat" you are now ready to vacuum the system down and recharge it. The high side port should be on the line between the condenser and the expansion valve or orifice tube while the low side port will be on the return line between the evaporator (firewall) and compressor.

The high side port is larger in size than the low side. If you are servicing the system or doing repairs that require the removal for the refrigerant continue down to the guide to the refrigerant removal section.

STEP 2: PREPARE THE GAUGE SET

A gauge set is needed to connect to the system on both high and low side pressure ports and it will also be used to vacuum down and recharge the system. Inspect the connections to make sure they are tight to avoid leakage. These units must be "air tight" and not have any leaks at hose fittings or valves. The red colored gauge and connector valve represents the high pressure side of the system while the blue color represents the low pressure side. The center hose (yellow) is connected to the vacuum pump and then the new refrigerant supply bottle or can. Both gauge valves should be closed before attaching them to the system.

STEP 3: CONNECT THE GAUGES TO THE SYSTEM

After repairs have been made locate the low side service port on the return hose to the compressor and then connect your gauges to the port by lifting up the connector ring and pushing downward. Then turn the valve screw (blue part) inward (clockwise)

this will open the service valve below. Repeat this process for both high and low side ports. The high and low side fittings will only work on their respective ports due to size constraints to avoid confusion. Once secured tighten the valve which activates the internal plunger that opens the service port valve to the refrigerant lines.

STEP 4: GAUGE READINGS

Now observe both high and low side gauges with the valves closed there should be little to no pressure in the system.

STEP 5: CONNECT THE VACUUM PUMP

Connect the center hose from the gauge set (yellow) to the vacuum pump and turn the unit on. This step is used to remove any moisture and static air from inside the system. These systems have a mixture of refrigerant and oil to keep the air conditioning compressor lubricated during operation. Measuring the amount of (peg) oil in the system is difficult because it's spread throughout the system, in other words if there is a major leak and oil is dripping out the system will need a small amount of oil. Unlike a very small leak which releases little to no oil you must be the judge of this and add appropriately.

STEP 6: VACUUM THE SYSTEM

Slowly open the low side gauge valve the pump will now start pulling vacuum throughout the system as the gauge needle slowly moves into vacuum. The pump will change in tone once the valve has been opened and it starts to pull air out of the system. Once the vacuum pump has been on for 30 minutes close the low side valve and turn the pump off. The system should hold at 28-29 inches. If the system never reaches 28-29 inches there is a large leak. If the system loses vacuum after the valve is closed there is a small leak and the system must be rechecked. System leaks can include a faulty O ring seal or a loose hose on the valve set. If the system holds vacuum for 15 minutes proceed to the next step.

Registration No.: .....

School of Refrigeration & Air-Conditioning_
Session: 2019-20 (Summer / Winter Semester)
B. Voc. Program, 1ST Semester,
End-Sem. Examination

Course Code: HVA1104 **Time: 2 Hours**
Course Name: Sheet metal & Welding **Max. Marks: 50**
Instruction: All question are Compulsory

Section – A

10X01 = 10 Marks

Q1While working in a workshop, ---------- is the main cause of accidents.

a) Help
b) Precautions
c) Carelessness
d) Data sheet

Q2Warning signs in the workshop should be obeyed

a)Sometimes
b)Always
c)At the teacher's instruction
d)When working at the bench

Q3To cut the sheet metal at 45 or 90 degrees, the---------- machine is used.

a) Notching
b) Drilling
c) Bending
d) Welding

Q4To protect your eyes you have to wear:

a)Safety shoes
b)Overall
c)Safety Glasses
d)Helmet

Q5) While working on the spot welding machines ---------- should be worn.

a)Gloves
b)Face shield
c)Apron
d)All of above

Q6) What should be the thickness of the metal sheet to be called as plate?

a).25mm-6.25mm
b)6.25mm-18mm
c)18-25mm

d)12 x 12 inches

Q7)To make a small indentation (centre hole) in sheet metal, a---------- is used.

a)Pencil
b)Center Punch
c)Needle
d)Scribber

Q8) To fasten the sheet metal with steel nail the ---------- is used.

a)Rivet Pliers
b)Pliers
c)Punch
d)Stappler

Q9) To bend the sheet metal by 180 degrees a ---------- is used.

a)Carperter's Hammer
b)Ball peen Hammer
c)Mallet
d)Sledge Hammer

Q10) One centimetre is equivalent to

a)10 mm
b)1 mm
c)0.1 mm
d)100 mm

Section – B

04X04 = 16 Marks

QB.1a)what is the difference between Sheet ,Plate and Foil ?Name and state the tools required by the welders?

QB.2Explain the working of Arc Welding machine ?

QB.3)What are the Advantages of D.C+ and D.C-?

QB.4)What are the safety procedures Required for a welder?(electric arc)

Section – C

04X06 = 24 Marks

QC1) What are the types of flames generated in Gas welding /OxyFuel Welding . Draw the Types of Flame and label it?

QC2)Write the difference between Permanent and temporary Joints?

QC3)What is brazing ?

Name and draw different types of Flames (Oxy Acetylene) in brazing is used ?

QC.4)Why Metal is shielded by a Gas or a Flux during welding ,
Mention the name of gases used to shield the work piece?

Registration No.: .....

School of Refrigeration & Air-Conditioning_
Session: 2019-20 (Summer / Winter Semester)
B. Voc. Program, _____ Semester,
End-Sem. Examination

Course Code:HVA1104 **Time: 2 Hours**
Course Name: Sheet Metal & welding **Max. Marks: 50**
Instruction: (if any)

Section – A

10X01 = 10 Marks

10 objective type questions, each question carries 01 mark.

Q1While working in a workshop, ---------- is the main cause of accidents.
a) Help
b) Precautions
c) Carelessness
d) Data sheet

Q2Warning signs in the workshop should be obeyed

a) Sometimes
b) Always
c) At the teacher's instruction
d) When working at the bench

Q3To cut the sheet metal at 45 or 90 degrees, the---------- machine is used.
a) Notching
b) Drilling
c) Bending
d) Welding

Q4To protect your eyes you have to wear:

a) Safety shoes
b) Overall
c) Safety Glasses
d) Helmet

Q5) While working on the spot welding machines ---------- should be worn.

a) Gloves
b) Face shield
c) Apron
d) All of above

Q6) What should be the thickness of the metal sheet to be called as plate?

a) .25mm-6.25mm
b) 6.25mm-18mm
c) 18-25mm
d) 12 x 12 inches

Q7)To make a small indentation (centre hole) in sheet metal, a---------- is used.

a) Pencil
b) Center Punch
c) Needle
d) Scribber

Q8) To fasten the sheet metal with steel nail the ---------- is used.

a) Rivet Pliers
b) Pliers
c) Punch
d) Stappler

Q9) To bend the sheet metal by 180 degrees a ---------- is used.

a) Carperter's Hammer
b) Ball peen Hammer
c) Mallet
d)Sledge Hammer

Q10) One centimetre is equivalent to

a) 10 mm
b) 1 mm
c) 0.1 mm
d) 100 mm

Section – B

04X04 = 16 Marks

B short answer type questions, each question carries 04 marks.

QB.1a)what is the difference between Sheet ,Plate and Foil ?Name and state the tools required by the welders?
Answer B.1)Sheet piece of metal that has a thickness less than 0.249 inches between 6-18 mm

b)Plate Piece of metal that has the thickness more than 18mm thickness is measured in terms of gauge also used particularly for heavy or pressurised vessel application weights much more than both sheet and foil
Foil any metal drawn in with thinner than 0.006 inches weight is also very less

QB.2Explain the working of Arc Welding machine ?
Answer b.2)Arc welding is a welding process, in which heat is generated by an electric arc struck between an electrode and the work piece.electric arc is luminous electrical discharge between two electrodes through ionized gas. Welding beads (electric cables) connecting the electrode and work piece to the power supply.

QB.3)What are the Advantages of D.C+ and D.C-?
Answer 3.

Advantages of

DC+	DC-
1.High Spatter 2.Penetration power is Good on low current range 3.High Current density and highly polarised attraction	1.Lower spatter 2.Penetration on higher current Good weld bead 3.Low current density and Low polarised attraction

QB.4)What are the safety procedures Required for a welder?(electric arc)
Answer B4)Safety Precautions used in the arc welding are as follows
Electric shock- Using Personal protective Equipment like non static shoes, proper clamping of earths lugs ,

Pre and Post check for wire wear and tear.

Spark and spatter -Sleeves and leather apron, leather gloves

Smoke and fumes -using nose mask and fume ventilation in the workshop

Heat radiation -use tongs or a long leg lenth material handling equipments to prevent from these

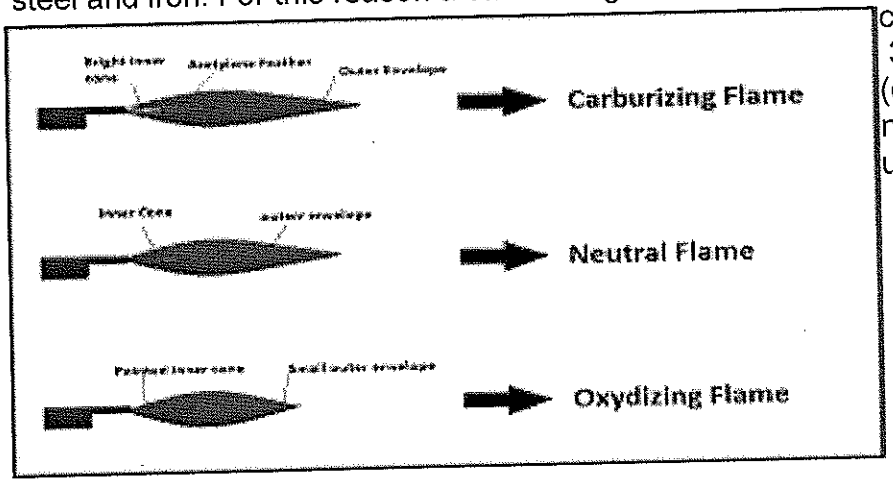
Chipped and hot slag particles ;should be using hard gloves while working

Hot jobs and stub ends using of infrared temperature to read the surface temprature and using tongs to move the heated base plate

Section – C

04X06 = 24 Marks

0C long type questions, each question carries 06 marks.
QC1) What are the types of flames generated in Gas welding /OxyFuel Welding . Draw the Types of Flame and label it?
Answer C1)There are **three** basic **flame types**:
Neutral (balanced), A neutral **flame** is named neutral since in most cases will have no chemical effect on the metal being welded.
2)Excess acetylene (carburizing), will produce iron carbide, causing a chemical change in steel and iron. For this reason a carburizing flame is not used on metals that absorb carbon



3)Excess oxygen (oxidizing) is hotter than a neutral flame and is often used on copper and zinc.

QC2)Write the difference between Permanent and temporary Joints?

Temporary Joint	Permanent Joint
Temporary joints allow easy dismantling of assembled components without breaking them.	Permanent joints don't allow dismantling of assembled components without rupturing them.
Temporary joints are not necessarily leak-proof.	Permanent joints are usually leak-proof.
Strength of temporary joint is comparatively less.	Strength of permanent joint is high. Usually joint strength is same with that of the components.
It facilitates fast, easy and cost efficient inspection. No destructive testing is required for inspection of joints.	As permanent joints cannot be disassembled easily, so inspection is difficult and costly. Often destructive testing is carried out, which damages the assembled structures.
Repair and replacement are also easy.	Repair and replacement are difficult and costly.
Temporary joints are suitable where frequent separation of assembled components is required.	Permanent joints are suitable for such applications where separation is usually not desired in the service life.

QC3)What is brazing ?
Name and draw different types of Flames (Oxy Acetylene)?
Answer QC3)**Brazing** is a metal-joining process in which two or more metal items are joined together by melting and flowing a filler metal into the joint, the filler metal having a lower melting point than the adjoining metal filler is filled by capillary action.

In welding the base metal is heated to molten temperature at the pool side while in brazing only the filler rod(lower temperature than base metal) is heated to melting temperature and allows to solidify.
Temprature range for brazing is above 450-970degree celcius
QC.4)Why Metal is shielded by a Gas or a Flux during welding ,
Mention the name of gases used to shield the work piece?
Answerc.4)The primary purpose of **shielding gas** is to prevent exposure of the molten weld pool to oxygen, nitrogen and hydrogen contained in the air atmosphere. The reaction of these elements with the weld pool can create a variety of problems, including porosity (holes within the weld bead) and excessive spatter.
Gases used to shield the work piece are
Argon
argon+co2 20% is used for short arc welding

Depending upon the Arc length the pressure of Argon and co2 is controlled as it provides best penetration power to protect the metal beads so formed

Registration No.: .....

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills
Session: 2019-20 (Summer Semester)
B. Voc. Program, 1st Semester,
End – Sem. Examination

Course Code: HVA1105 **Time: 2 Hours**
Course Name: RAC Electricals **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. Farad (F) is the unit of:
   (a) Capacitance (b) inductance (c) Resistance (d) none of these
2. Unit of charge is:
   (a) coulomb (b) Ampere (c) volt (d) none of these
3. Two resisters of resistance R1 and R2 are connected in series the equivalent resistance (R) is:
   (a) R= R1+R2 (b) R=(R1R2)/(R1+R2)
   (c) R=(R1+R2)/(R1R2) (d) none of these
4. The property of a material which opposes the production of magnetic flux is known as:
   (a) Reluctance (b) mmf (c) Permittivity (d)None of these
5. Watt is the unit of:
   (a) Power (b) Energy (c) current (d) None of these
6. What are the different types of conduits available?
   (a) PVC conduit (b) Flexible conduit
   (c) Heavy gauge steel screwed conduit (d) All of these
7. The unsafe act or unsafe condition can leads to an:
   (a) Accident (b) safety (c) both a and b (d) none of these
8. In an atom particles having positive charge is called .....?
   (a) Proton (b) Neutron (c) Electron (d) None of these
9. Digital multi-meter is used for:
   (a) measuring AC and DC current, voltage and resistance
   (b) measuring AC current and voltage
   (c) measuring DC current and resistance
   (d) measuring AC voltage and resistance
10. A current is said to be alternating when it changes in
   (a) Magnitude only (b) Direction only
   (c) Both Magnitude and direction (d) None of these

B

Registration No.: .....

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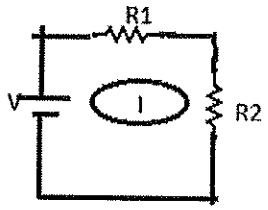
Section – B

04x04 = 16 Marks

1. Find the current in circuit given bellow when applied voltage V=100 V and R1=R2= 10 ohms.

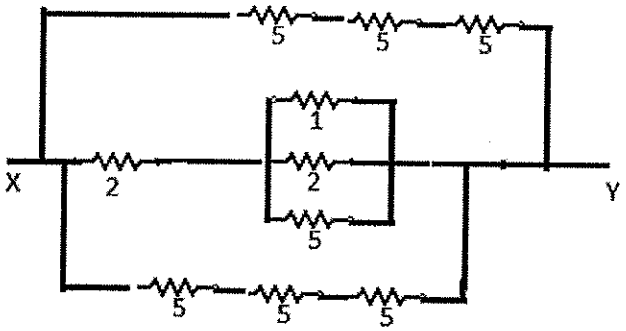


2. Explain Faraday's law of electromagnetic induction.
3. Briefly define Electricity.
4. Define conductor and insulator in terms of resistance.

Section – C

04x06 = 24 marks

1. Explain color coding of resistor and represent 20k Ω with 10% tolerance resistance using color codes.
2. Distinguish between Magnetic and Electrical circuits.
3. Find the equivalent resistance between X and Y (Given all the resistances are in ohms).



4. Complete the following table for a circuit consisting of a voltage source connected in series with resistance.

	Voltage (V)	Current (A)	Power (w)	Resistance (ohm)
1.	100			1000
2.	500	20		
3.		10	1000	

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

School of Electrical Skills
1st Semester, End-Sem. Examination
B. Voc. Program, Summer Semester (2019-20)

Course Code: HVA1105
Course Name: RAC Electricals

Time: 2 Hours
Max. Marks: 50

Section – A

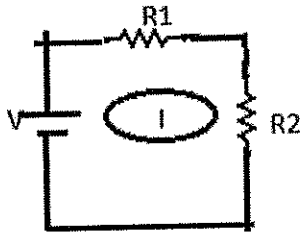
10 X01 = 10 Marks

1. (a) Capacitance
2. (a) coulomb
3. (a) R= R1+R2
4. (a) Reluctance
5. (a) Power
6. (d) All of these
7. (a) Accident
8. (a) Proton
9. (a) measuring AC and DC current, voltage and resistance
10. (c) Both Magnitude and direction

Section – B

04X04 = 16 Marks

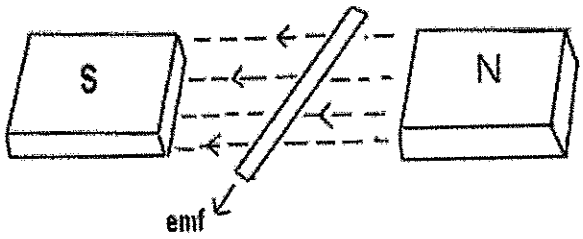
1. Find the current in circuit given bellow when applied voltage V=100 V and R1=R2= 10 ohms.



Ans.

V-I*R1-I*R2=0 or V= I*R1+I*R2
V=I(R1+R2)
100=I(10+10)
I= 100/20
I=5A

2. Explain Faraday's law of electromagnetic induction?



Ans. Faraday's First Law:
Whenever a conductor is placed in a varying magnetic field an EMF gets induced across the conductor (called as induced emf), and if the conductor is a closed circuit then induced current flows through it.
Magnetic field can be varied by various methods -
1. By moving magnet
2. By moving the coil
3. By rotating the coil relative to magnetic field
Faraday's Second Law:

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Faraday's second law of electromagnetic induction states that, the magnitude of induced emf is equal to the rate of change of flux linkages with the coil. The flux linkages is the product of number of turns and the flux associated with the coil.

3. Briefly define Electricity.

Ans.

Electricity is a form of energy. Electricity is the flow of electrons. All matter is made up of atoms, and an atom has a center, called a nucleus. The nucleus contains positively charged particles called protons and uncharged particles called neutrons. The nucleus of an atom is surrounded by negatively charged particles called electrons. The negative charge of an electron is equal to the positive charge of a proton, and the number of electrons in an atom is usually equal to the number of protons. When the balancing force between protons and electrons is upset by an outside force, an atom may gain or lose an electron. When electrons are "lost" from an atom, the free movement of these electrons constitutes an electric current.

4. Define conductor and insulator in terms of resistance.

Ans.

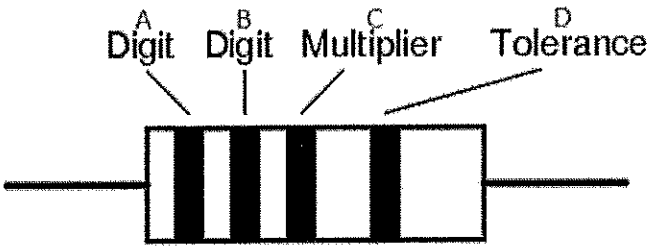
- Resistance is the 'opposition' to the current flow measured in ohms (Ω)
- Conductors have a low value of resistance
- Insulators have a very high resistance
- Load in DC/AC circuits

Section – C

04X06 = 24 Marks

1. Explain color coding of resistor and represent 20k Ω with 10% tolerance resistance using color codes.

Color	Digit
Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9
Gold	5%
Silver	10%
(none)	20%



BSDU

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The value of resistance can be calculated by

$R = AB * 10^{C} \pm D$

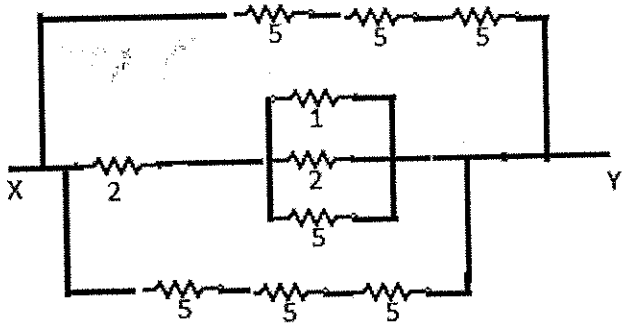
Hence the 20kΩ resistance with 10% tolerance can be represented as

Red, Black, Orange, Silver.

1. Distinguish between Magnetic and Electric circuits.

Electric Circuit	*Magnetic Circuit*
1. E.M.F. in volts	1. M.M.F. in Ampere Turns
2. Current in Amperes	2. Flux in Webers
3. Resistance in Ohms $R = \frac{\rho l}{a}$	3. Reluctance in AT/Wb $S = \frac{l}{a\mu}$
4. Conductivity $= \left(\frac{1}{\text{resistivity}}\right)$	4. Permeability $= \left(\frac{1}{\text{reluctivity}}\right)$
5. Conductance $= \left(\frac{1}{\text{resistance}}\right)$	5. Permeance $= \left(\frac{1}{\text{reluctance}}\right)$
6. Current $= \left(\frac{\text{e.m.f.}}{\text{resistance}}\right)$	6. Flux $= \left(\frac{\text{M.M.F.}}{\text{reluctance}}\right)$
7. Resistivity	7. Reluctivity

2. Find the equivalent resistance between X and Y (Given all the resistances are in ohms).



RT1= 5+5+5

=15

RT2=5+5+5

=15

1/RT3=1/1+1/2+1/5

1/RT3=1+.5+.2

1/RT3=1.7

RT3=0.588

RT4=2+0.588

RT4=2.588

1/R total =[1/15+1/15+1/2.588]

1/R total=0.519732

R total=1.924068

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3. Complete the following table for a circuit consisting of a voltage source connected in series with resistance.

Ans.

	Voltage (V)	Current (A)	Power (w)	Resistance (ohm)
1.	100			1000
2.	500	20		
3.		10	1000	

Ans

V=100
R=100
Then I= 100/1000
0.1
P=V*I=.1*100=10
P=500*20=10000
R=V/I=500/20=25
P=1000
I=10
1000=10^2*R
R=1000/100=10
V=I*R
V=10*10

	Voltage (V)	Current (A)	Power (w)	Resistance (ohm)
1.	100	0.1	10	1000
2.	500	20	1000	25
3.	100	10	1000	10

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Registration No.: .....

School of HVAC Skills

Session: 2019-20 (Summer Semester)

B. Voc. Program, 1st Semester,

End-Sem. Examination

Course Code: HVAC1106 **Time: 2 Hours**

Course Name: Electronics and Instrumentation **Max. Marks: 50**

Section – A

10X01 = 10 Marks

1. A capacitor stores energy within a dielectric between the conducting plates in the form of:
   a) A magnetic field b) Positive voltage
   c) Negative voltage d) An electric field

2. In a reverse biased PN junction, the current through the junction increases abruptly at
   a) 0.5 V b) 1.1 V
   c) 0.72 V d) Breakdown voltage

3. Power is defined as:
   a) The rate at which energy is used b) Watts
   c) Energy d) The rate at which energy is generated

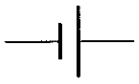
4. When a pure semiconductor is heated, it's resistance-
   a) Goes down b) Goes up
   c) Remains the same d) None of the above

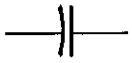
5. Efficiency of LED is given by
   (a) Light to light conversion b) Light to electrical conversion
   (c) Electrical power to visible light conversion d) None of above

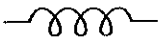
6. The value of α of a transistor is-
   a) More than 1 b) Less than 1
   c) 1 d) None of the above

7. With the increase in the intensity of light, the resistance of a photovoltaic cell
   a) Increases b) Decreases
   c) Remains same d) None of these

8. The symbol used for capacitance is-

a) 

b) 

c) 

d) 

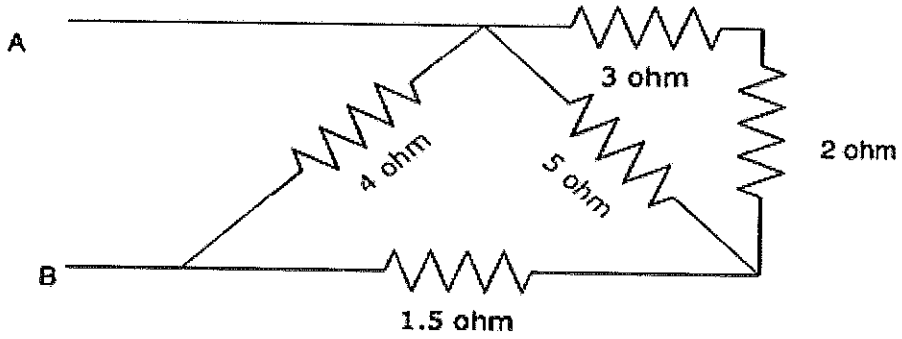
9. The insulating medium between the two plates of capacitor is known as-
   a) Electrode b) Capacitive medium
   c) Conducting medium d) Dielectric

10. The composition of soft solder is
    a) lead-37%, tin-63%
    b) lead-50%, tin-50%
    c) lead-63%, tin-37%
    d) lead-70%, tin-30%

Section – B

04X04 = 16 Marks

1. Calculate the equivalent resistance between A and B.



2. What is the difference between intrinsic and extrinsic semiconductors? Explain.
3. What is the function of photovoltaic cell? Write its applications.
4. What is a thermistor? How does the thermistor "read" temperature?

Section – C

04X06 = 24 Marks

1. What is the difference between active and passive components. Draw symbols of active and passive components with explanation.
2. What is the function of a transducer? Is a thermocouple a transducer? What are the applications of transducers?
3. What is a PN diode? Explain its applications.
4. What is the function of transistor? Explain its Common Base configuration.

BHARTIYA SKILL DEVELOPMENT UNIVERSITY

Registration No.: .....

Set - B
Answer key

School of HVAC Skills

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   d) None of the above

a) Goes down

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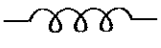
b) Decreases

8. The symbol used for capacitance is-

a) 

b) 

c) 

d) 

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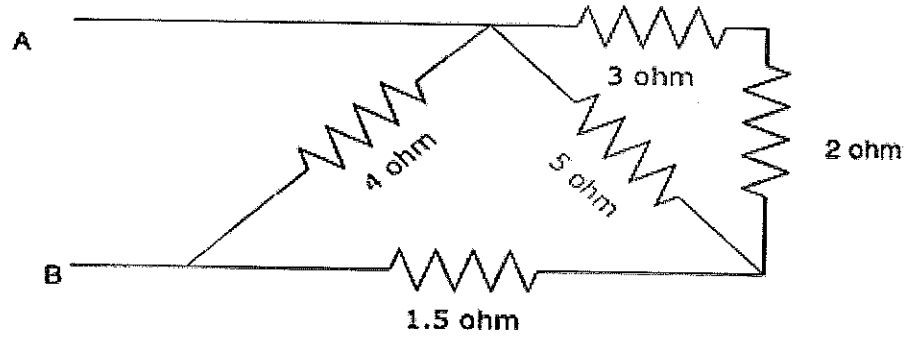


A. R = ((2+3) || 5) + 1.5) || 4. The 2 and the 3 ohms resistor are in series.

The equivalent of these two resistors is in parallel with the 5 ohms resistor.

The equivalent of these three resistances is in series with the 1.5 ohms resistor.

Finally, the equivalent of these resistances is in parallel with the 4 ohms resistor.

2. What is the difference between intrinsic and extrinsic semiconductors? Explain.

Ans. Difference between intrinsic and extrinsic semiconductors

Parameter	Intrinsic Semiconductor	Extrinsic Semiconductor
Form of semiconductor	Pure form of semiconductor.	Impure form of semiconductor.
Conductivity	It exhibits poor conductivity.	It possesses comparatively better conductivity than intrinsic semiconductor.
Band gap	The band gap between conduction and valence band is small.	The energy gap is higher than intrinsic semiconductor.
Fermi level	It is present in the middle of forbidden energy gap.	The presence of fermi level varies according to the type of extrinsic semiconductor.

Parameter	Intrinsic Semiconductor	Extrinsic Semiconductor
Dependency	The conduction relies on temperature.	The conduction depends on the concentration of doped impurity and temperature.
Carrier concentration	Equal amount of electron and holes are present in conduction and valence band.	The majority presence of electrons and holes depends on the type of extrinsic semiconductor.
Type	It is not further classified.	It is classified as p type and n type semiconductor.
Example	Si, Ge etc.	GaAs, GaP etc.

3. What is the function of photovoltaic cell? Write its applications.

Ans. A photovoltaic cell (PV cell) is a specialized semiconductor diode that converts visible light into direct current (DC). Some PV cells can also convert infrared (IR) or ultraviolet (UV) radiation into DC electricity. Photovoltaic cells are an integral part of solar-electric energy systems, which are becoming increasingly important as alternative sources of utility power. The first PV cells were made of silicon combined, or doped, with other elements to affect the behavior of electrons or holes.

Other materials, such as copper indium diselenide (CIS), cadmium telluride (CdTe), and gallium arsenide (GaAs), have been developed for use in PV cells. In a PV cell, flat pieces of these materials are placed together, and the physical boundary between them is called the P-N junction. The device is constructed in such a way that the junction can be exposed to visible light, IR, or UV. When such radiation strikes the P-N junction, a voltage difference is produced between the P type and N type materials. Electrodes connected to the semiconductor layers allow current to be drawn from the device.

Applications: Large sets of PV cells can be connected together to form solar modules, arrays, or panels. The use of PV cells and batteries for the generation of usable electrical energy is known as photovoltaics. One of the major advantages of photovoltaics is the fact that it is non-polluting, requiring only real estate (and a reasonably sunny climate) in order to function. Another advantage is the fact that solar energy is unlimited.

Once a photovoltaic system has been installed, it can provide energy at essentially no cost for years, and with minimal maintenance. For low-power portable electronics, like calculators or small fans, a photovoltaic array may be a reasonable energy source rather than a battery. Although using photovoltaics lowers the cost of the device to the user-who will never need to buy batteries-the cost of manufacturing devices with photovoltaic arrays is generally higher than the cost of manufacturing devices to which batteries must be added.

Therefore, the initial cost of photovoltaic devices is often higher than battery-operated devices. In other situations, such as solar battery chargers, watches, and flashlights, the photovoltaic array is used to generate electricity that is then stored in batteries for use later.

4. What is a thermistor? How does the thermistor "read" temperature?

Ans. A thermistor is a resistance thermometer, or a resistor whose resistance is dependent on temperature. The term is a combination of "thermal" and "resistor". It is made of metallic oxides, pressed into a bead, disk, or cylindrical shape and then encapsulated with an impermeable material such as epoxy or glass.

There are two types of thermistors:

- Negative Temperature Coefficient (NTC)
- Positive Temperature Coefficient (PTC).

With an NTC thermistor, when the temperature increases, resistance decreases. Conversely, when temperature decreases, resistance increases. This type of thermistor is used the most. A PTC thermistor works a little differently. When temperature increases, the resistance increases, and when temperature decreases, resistance decreases. This type of thermistor is generally used as a fuse. Typically, a thermistor achieves high precision within a limited temperature range of about 50°C around the target temperature. This range is dependent on the base resistance. The thermistor symbols are:

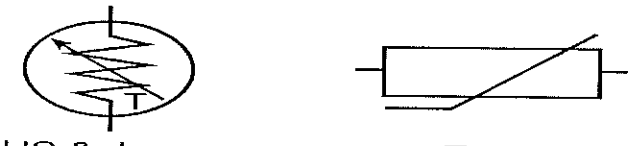


Figure 1: Thermistor Symbol — US and Japan

The arrow by the T signifies that the resistance is variable based on temperature. The direction of the arrow or bar is not significant. Thermistors are easy to use, inexpensive, sturdy, and respond predictably to changes in temperature. While they do not work well with excessively hot or cold temperatures, they are the sensor of choice for applications that measure temperature at a desired base point. They are ideal when very precise temperatures are required.

Some of the most common uses of thermistors are in digital thermometers, in cars to measure oil and coolant temperatures, and in household appliances such as ovens and refrigerators, but they are also found in almost any application that requires heating or cooling protection circuits for safe operation. For more sophisticated applications, such as laser stabilization detectors, optical blocks, and charge coupled devices, the thermistor is built in. For example, a 10 kΩ thermistor is the standard that is built into laser packages.

How does the thermistor "read" temperature?

A thermistor does not actually "read" anything, instead the resistance of a thermistor changes with temperature. How much the resistance changes depend on the type of material used in the thermistor. Unlike other sensors, thermistors are nonlinear, meaning the points on a graph representing the relationship between resistance and temperature will not form a straight line. The location of the line and how much it changes is determined by the construction of the thermistor. How the change in resistance is converted into measurable data? is shown in graph below.

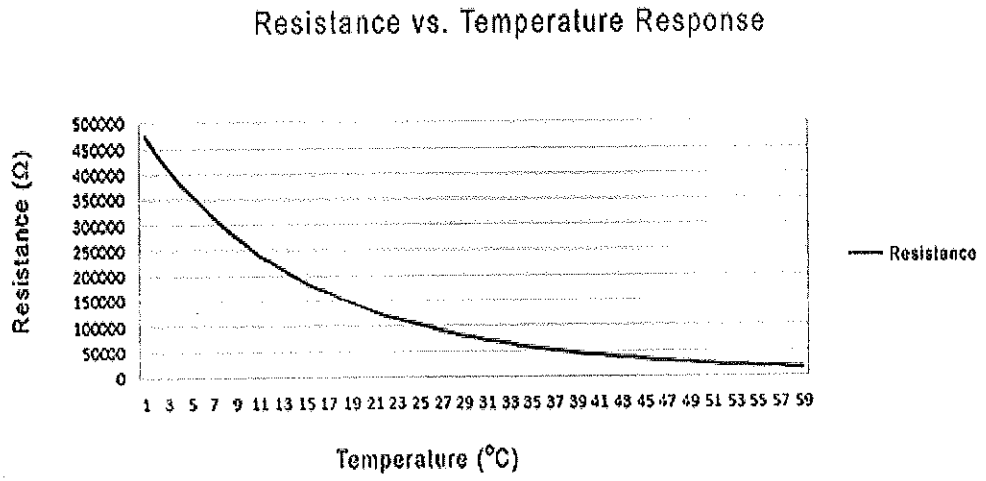


Figure 2: Resistance vs. Temperature

Section – C

04X06 = 24 Marks

1. What is the difference between active and passive components. Draw symbols of active and passive components with explanation.

Ans. Difference between active and passive components-

BASIS	ACTIVE COMPONENTS	PASSIVE COMPONENT
Nature of source	Active components deliver power or energy to the circuit.	Passive elements utilizes power or energy in the circuit.
Examples	Diodes, Transistors, SCR, Integrated circuits etc.	Resistor, Capacitor, Inductor etc.
Function of the component	Devices which produce energy in the form of voltage or current.	Devices which stores energy in the form of voltage or current.
Power Gain	They are capable of providing power gain.	They are incapable of providing power gain.
Flow of current	Active components can control the flow of current.	Passive components cannot control the flow of the current.

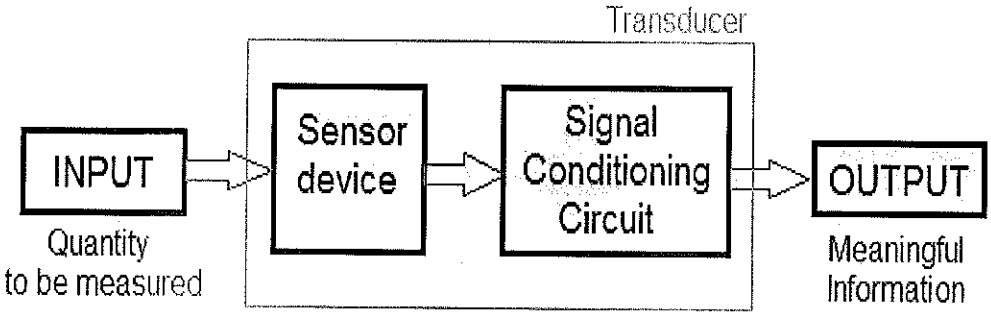
BASIS	ACTIVE COMPONENTS	PASSIVE COMPONENT
Requirement of external source	They require an external source for the operations.	They do not require any external source for the operations.
Nature of energy	Active components are energy donor.	Passive components are energy acceptor.

2. What is the function of a transducer? Is a thermocouple a transducer? What are the applications of transducers?

Ans. The device which converts the one form of energy into another is known as the transducer. The process of conversion is known as transduction. The conversion is done by sensing and transducing the physical quantities like temperature, pressure, sound, etc. The electrical transducer converts the mechanical energy into an electric signal. The electrical signal may be voltage, current and frequency.

Thermocouple is acts as a transducer it is used to measure heat (temperature) but additional circuit or component needed like voltmeter, display etc together form a temperature sensor, hence the transducer just convert one form of energy into another form of energy, and all remaining work done by additional connected circuit.

For example, if we use a thermocouple without an additional circuit it's called a transducer because it converts heat (temperature) energy into electrical energy (mv). But if we use thermocouple with additional circuit like voltmeter we can detect temperature using its reference table which is meaningful output.



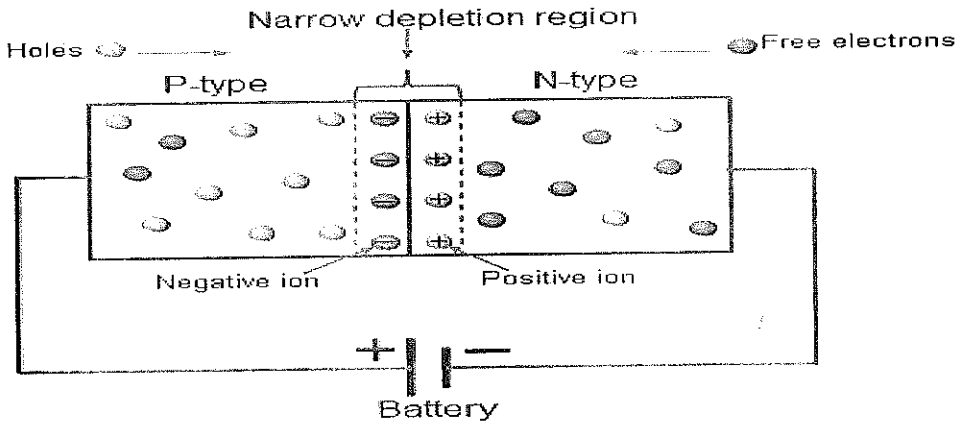
The following are the application of the transducers.

- The transducer measures the load on the engines.
- It is used as a sensor for knowing the engine knock.
- The transducers measure the pressure of the gas and liquid by converting it into an electrical signal.
- It converts the temperature of the devices into an electrical signal or mechanical work.

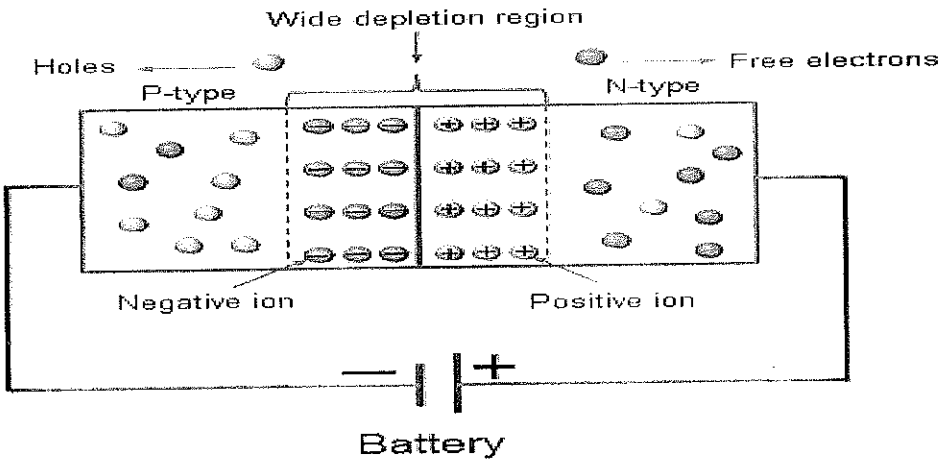
- The transducer is used in the ultrasound machine. It receives the sound waves of the patient by emitting their sound waves and pass the signal to the CPU.
- The transducer is used in the speaker for converting the electrical signal into sound.
- It is used in the antenna for converting the electromagnetic waves into an electrical signal.

3. What is a PN diode? Explain its applications.

Ans. A p–n diode is a type of semiconductor diode based upon the p–n junction. The diode conducts current in only one direction, and it is made by joining a *p*-type semiconducting layer to an *n*-type semiconducting layer. Semiconductor diodes have multiple uses including rectification of alternating current to direct current, detection of radio signals, emitting light and detecting light. There are three possible biasing conditions and two operating regions for the typical PN-Junction Diode, they are zero bias, forward bias and reverse bias. A p-n junction diode is a two terminal device that allows electric current in one direction and blocks electric current in another direction.



Forward bias



Reverse bias

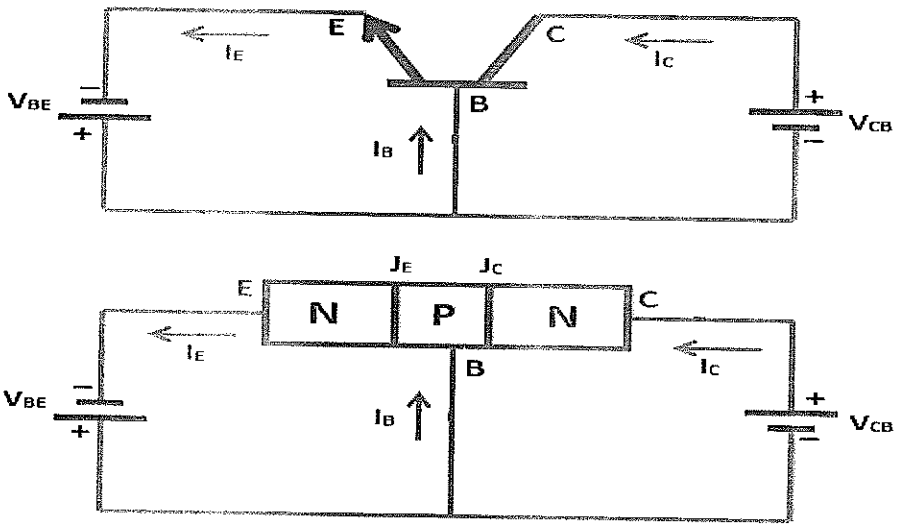
A p-n junction diode allows electric current when it is forward biased and blocks electric current when it is reverse biased. This action of p-n junction diode enables us to use it as a rectifier. The diode finds number of applications as given below:

- Rectification
- Diodes are used in clamping circuits for DC restoration.
- Diodes are used in clipping circuits for wave shaping.
- Diodes are used in voltage multipliers.
- Diodes are used as switch in digital logic circuits used in computers.
- Diodes are used in demodulation circuits.
- Laser diodes are used in optical communications.
- Light Emitting Diodes (LEDs) are used in digital displays.
- Diodes are used in voltage regulators.

4. What is the function of transistor? Explain its CB configuration.

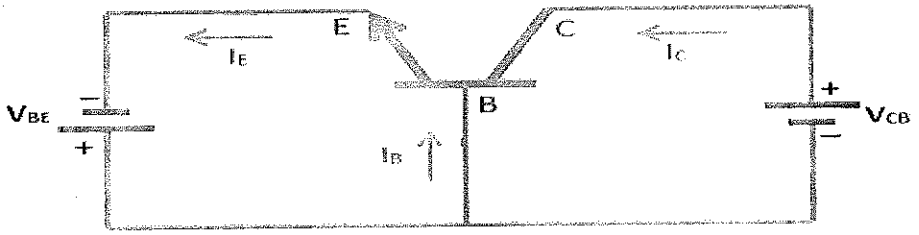
Ans. A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. The naming of the three basic transistor configurations indicates the transistor terminal that is common to both input and output circuits. This gives rise to the three terms: common base, common collector and common emitter.

Common Base Configuration: In common base configuration, emitter is the input terminal, collector is the output terminal and base terminal is connected as a common terminal for both input and output. That means the emitter terminal and common base terminal are known as input terminals whereas the collector terminal and common base terminal are known as output terminals. In common base configuration, the base terminal is grounded so the common base configuration is also known as grounded base configuration. Sometimes common base configuration is referred to as common base amplifier, CB amplifier, or CB configuration.

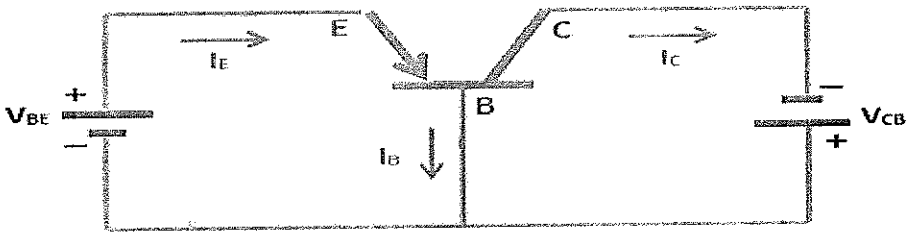


Common base configuration

The input signal is applied between the emitter and base terminals while the corresponding output signal is taken across the collector and base terminals. Thus the base terminal of a transistor is common for both input and output terminals and hence it is named as common base configuration. The supply voltage between base and emitter is denoted by V_{BE} while the supply voltage between collector and base is denoted by V_{CB}. In every configuration, the base-emitter junction J_E is always forward biased and collector-base junction J_C is always reverse biased. Therefore, in common base configuration, the base-emitter junction J_E is forward biased and collector-base junction J_C is reverse biased. The common base configuration for both NPN and PNP transistors is shown in the below figure.



NPN Transistor



PNP transistor

Common base configuration

From the above circuit diagrams of NPN and PNP transistors, it can be seen that for both NPN and PNP transistors, the input is applied to the emitter and the output is taken from the collector. The common terminal for both the circuits is the base.