ELECTRICAL ENGINEERING MATERIALS

Unit V : Special Purpose Materials

Topic: Soldering, Bimetals and Fuses

Important Questions with Answers (3rd Semester, Electrical Engg.)

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Short Answer Questions

Q.1 Explain the process of soldering and the properties of materials used as solder.

Ans. Soldering is the process of joining two metal parts by melting a filler metal called solder into the joint. The solder melts at a lower temperature than the metals being joined, so the parts themselves do not melt. Solder is an alloy of tin and lead (about 60:40 or 63:37, melting at about 183 to 190 °C).

Process:

1. Clean the surfaces to be joined with a file or emery paper.
2. Heat the soldering iron.
3. Apply flux on the joint (or use flux-cored solder).
4. Heat the joint with the iron tip, not the solder.
5. Touch the solder to the heated joint. It melts and flows into the joint.
6. Remove the solder and then the iron. Keep the joint still until it sets.
7. Clean the extra flux and check that the joint is smooth and shiny.

Properties of a good solder:

1. Low melting point, lower than the metals joined.
2. Good wetting and flow.
3. Good adhesion and strength.
4. Good electrical conductivity.
5. Resistance to corrosion.
6. Quick setting from liquid to solid.

Note: A dull, grainy joint is a dry joint. It has high resistance and may fail. Values are approximate textbook values and are not given in the syllabus.

Q.2 What is flux? Differentiate between soft solder and hard solder.

Ans. Flux is a chemical paste or liquid that removes the oxide film from the metal surface, stops fresh oxide from forming while heating, and helps the molten solder to flow and stick. Rosin (resin) flux is used for electrical work because it does not corrode. Acid fluxes such as zinc chloride corrode and are not used for electrical joints.

Basis	**Soft solder**	**Hard solder**
Composition	Tin and lead	Copper-zinc (brazing) or silver alloys
Melting point	Low (below about 450 °C)	Higher (above about 450 °C)
Joint strength	Lower	Much stronger

Use	Electrical and electronic joints	Heavy mechanical joints

Q.3 Write a short note on bi-metals and its applications.

Ans. A bimetallic strip is made of two thin strips of different metals, such as brass and invar, firmly joined along their length. The two metals have different coefficients of linear expansion.

Principle: when heated, the metal with larger expansion becomes longer than the other. Since they are joined, the strip bends towards the metal that expands less. When it cools, it becomes straight again.

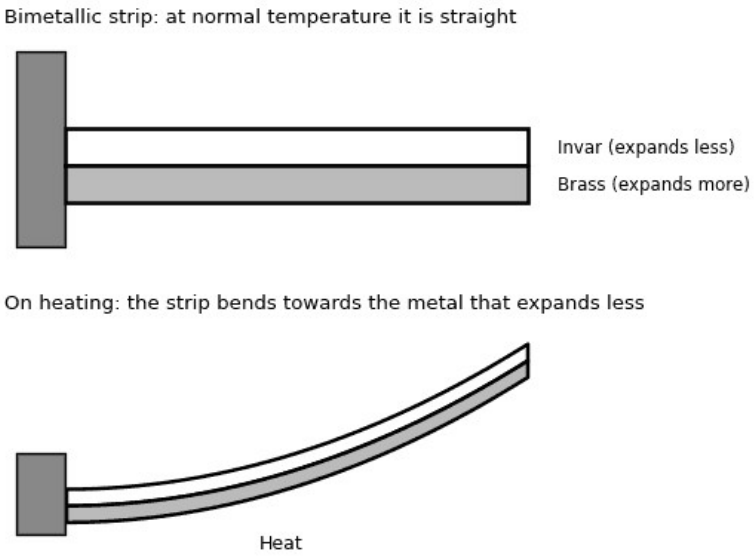


Fig. 1 Bending of a bimetallic strip on heating

Applications:

1. Thermostats in irons, heaters, geysers, refrigerators and ovens.
2. Thermal overload relays in motor starters.
3. Thermal trip of circuit breakers (MCB).
4. Flashers of vehicle indicators and decoration lamps.
5. Fire alarms and dial thermometers.

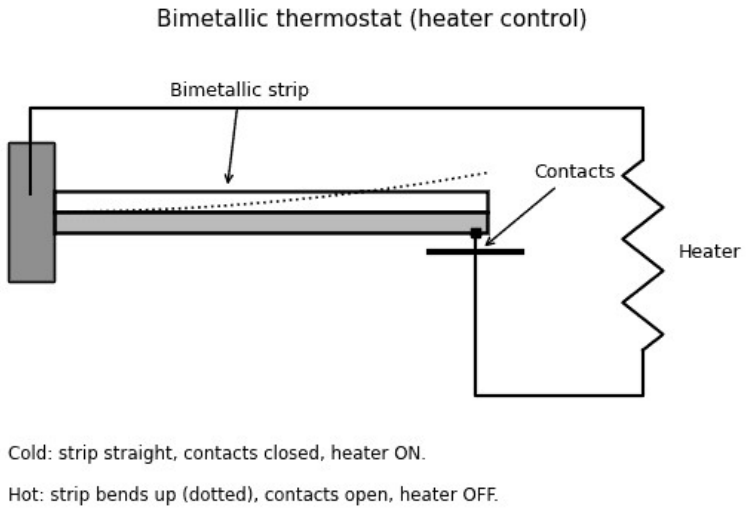


Fig. 2 Bimetallic thermostat controlling a heater

Remember: In the thermostat, the contacts are closed when cold and the heater is on. When the strip heats and bends, the contacts open and the heater switches off.

Q.4 Discuss fuse and the important properties of a fuse wire.

Ans. A fuse is a protective device that contains a thin wire or strip called the fuse element. When the current exceeds a safe value (overload or short circuit), the element becomes hot, melts and opens the circuit. It works on the heating effect of current (I squared R). The rated current is the largest current the fuse can carry continuously. The fusing current is the minimum current at which the element melts, and it is always more than the rated current.

Properties of a good fuse wire:

1. Low melting point, so that it melts quickly at the fusing current.
2. Low resistance (high conductivity), so that it does not waste power or get hot at normal current.
3. Free from deterioration: it should not oxidise or change with time.
4. Low cost.
5. Predictable behaviour: it should melt at the same current each time.
6. It should not give off harmful fumes or spatter hot metal.

Remember: The statement that a fuse wire has a high melting point is False.

Q.5 Name the fuse element materials. Describe the construction and materials of a cartridge fuse.

Material	Approximate melting point	Use
Tin-lead alloy	190 to 250 °C	Low-current rewirable fuses
Tin, lead, zinc	232, 327, 420 °C	Low-current fuses
Copper	About 1085 °C	Higher-current fuses
Silver	About 960 °C	Cartridge and HRC fuses

In a cartridge fuse the element is sealed inside a tube. This protects the element and holds the arc inside when it melts.

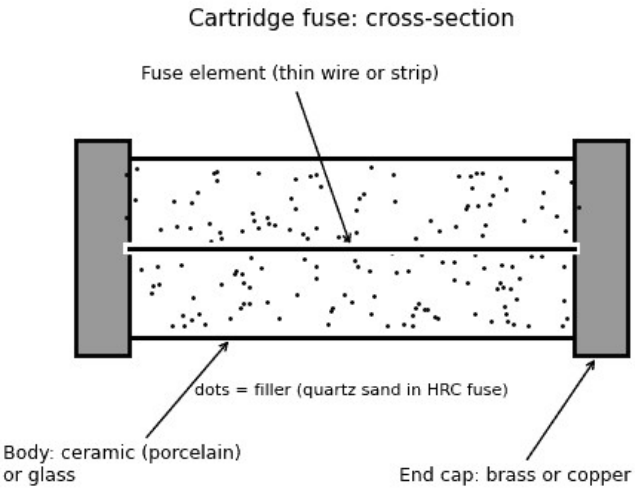


Fig. 3 Cross-section of a cartridge fuse

1. **Body:** ceramic (porcelain) for higher ratings and HRC fuses, or glass for low-current fuses.
2. **End caps:** brass or copper.
3. **Element:** silver, copper or tin-lead alloy.
4. **Filler (HRC fuses):** quartz sand, which cools and quenches the arc.

Long Answer Question

Q.6 Explain solder, bimetallic strip and fuse with their materials, properties and applications.

Ans. Solder, bimetallic strip and fuse are three special-purpose materials used in electrical work.

Item	Material	Properties	Applications
Solder	Tin-lead alloy (about 60:40 or 63:37), used with flux	Low melting point (about 183 to 190 °C), good wetting, good conductivity, quick setting	Joining wires, components and terminals
Bimetallic strip	Brass (or copper) with invar or steel	Two metals with different expansion; bends towards the metal that expands less on heating	Thermostats, overload relays, MCB thermal trip, flashers
Fuse element	Tin-lead alloy, tin, zinc, copper or silver	Low melting point, low resistance, no deterioration, low cost	Protection against overload and short circuit

Notes:

1. Soldering steps: clean, heat iron, apply flux, heat joint, add solder, let it cool.
2. The bimetallic thermostat opens its contacts when the strip heats and bends.
3. A cartridge fuse has a ceramic or glass body, brass end caps, a silver or copper element and sand filler in HRC types.

Note: Values are approximate textbook values and are not given in the syllabus.

Points to Remember (for MCQ and True/False)

1. Solder is an alloy of tin and lead.
2. A fuse wire has a low melting point (the statement "high melting point" is False).
3. The body of a cartridge fuse is made of ceramic (porcelain) or glass.
4. A bimetallic strip bends because its two metals expand by different amounts.
5. Rosin flux is used for electrical soldering; acid flux is not.
6. A fuse works on the heating effect of current.
7. Fusing current is more than the rated current of a fuse.
8. Bimetals are used in thermostats and thermal overload relays.