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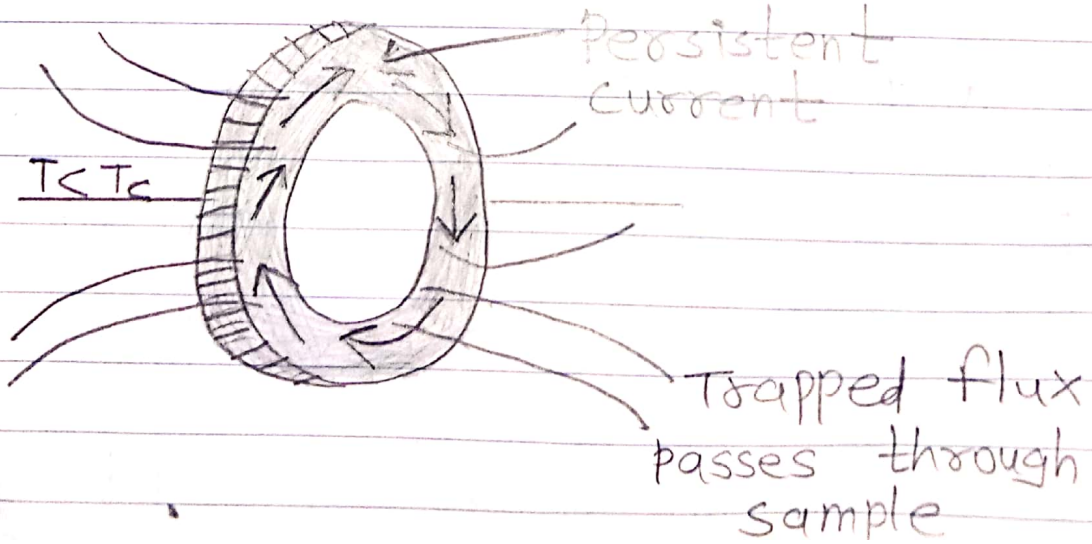
Assignment - 9
Superconductor.

Q1.) Define critical magnetic field and persistent current.

Ans 1.] **Critical magnetic field:-** The minimum applied magnetic field necessary to destroy superconductivity and further restore the normal resistivity is called critical magnetic field H_c.

$$H_c = H_0\left[1 - \left(\frac{T}{T_c}\right)^2\right]$$

2.] **Persistent current:-** The flux is trapped inside the ring that is in the hole of the ring as the flux lines cannot thread through the ring, but it must pass through the ring. Due to this a large current is induced by the collapsing field that maintains the trapped flux. This trapped current is called persistent current.



Q2) Differentiate between type I and type II superconductors.

Ans

Type-I superconductors	Type-II superconductors
1) In Type-I superconductor magnetic flux is completely excluded below critical magnetic field. It behaves completely diamagnetic in nature.	1) In Type-II superconductor magnetic flux does not excluded completely below critical magnetic field. A mixed state (superconducting + normal state) exists. So, it does not behave completely diamagnetic in nature.
2) The change from super-conducting state to normal state is sudden.	2) The change from super-conducting state to normal state is gradual.
3) Less industrial applications.	3) More industrial applications.
4) It is known as soft superconductor.	4) It is known as hard superconductor.
5) Example- Pure element like Al, In, Zn, Mo, Sn.	5) Example- Alloy like Nbn, Nb_3Sn, $BaBi_3$, $CoSi_2$, HTS.

Q3) What are SQUIDS? Explain their applications in brief.

Ans 1) SQUIDS (Superconducting Quantum Interfering Devices) are among the most sensitive devices, certainly the most sensitive magnetic field detectors.

2) It is an ultrasensitive detector of

magnetic flux, made up of a superconducting ring interrupted by one or two Josephson Junctions.

3.) This means a SQUID is capable of detecting magnetic fields of around 2pT.

II Applications of SQUID are:-

1.) SQUIDS have been used for a variety of testing purposes that demand extreme resistivity, including engineering, medical and geological equipment. Because they can measure changes in magnetic field with ultra high resistivity, but they do not have to come in contact with a system that they are testing.

2.) Magneto Encephalography (MEG):-

i) MEG is a non-invasive method of recording minute maghetic fields emanating from the brain. MEG is also known as Neuromagnetometer It consists of a multi-million dollar helmet like instrument which is placed around th subject's head.

ii) The helmet is made up of 2 probes or dewars which each contain 37 SQUIDs. The SQUIDs are kept cool by bathing

the magnetic detector coils at a temperature of $-269^{\circ}C$ and the device works by picking up the tiny magnetic fluxes from the brain and using them to induce small currents in the coils.

iii) Every single quantum of magnetic field is enough to produce a measurable current in the coil. The current in the coil then induces a magnetic field in the SQUID.

3) Earthquake detection:- SQUIDs are used to detect the probable earthquake time due to probable change in magnetic field in Earth core, which occurs due to development of stress or strain in Earth core. It is known that Earthquake and tsunamis are accompanied by localized changes in the geo-magnetic field.