Ferromagnetism: Exhibits spontaneous magnetization: A net magnetic moment in the absence of an external magnetic field.

spin ← ↑ ↑ ↑ ↑ ↑ ↑
alignment.

Ferrimagnetism: Some magnetic moments point in the opposite direction but have smaller contribution, so there is still a spontaneous magnetization.

↑ ↑ ↓ ↑ ↓

Anti-ferromagnetism: The magnetic moments of atoms — usually related to the spins of ēs, align in a regular pattern with neighboring spins (on different sublattices) pointing in opposite directions with same magnitude

↑ ↓ ↑ ↓
↓ ↑ ↓ ↑
↑ ↓ ↑ ↓

Paramagnetism: no spontaneous magnetization
However, some materials are weakly attracted by an externally applied magnetic field. The spin align in the direction of applied field.

$$E(f) = \{ f : [0, 1] \} \rightarrow R^3$$

if f is continuous

Density of states: Number of states per unit energy range that are available to be occupied.

The $g(E)dE$ is the number of available quantum states in the energy range E and E+dE.

Effective mass $m^* = \dfrac{\hbar^2}{\left(\dfrac{d^2E}{dk^2}\right)} = \dfrac{1}{\dfrac{d^2E}{\hbar^2 dk^2}}$

$$= \frac{1}{\left(\dfrac{d^2E}{dp^2}\right)^2} \quad \because p = \hbar k$$

Ge – 32 → $3d^{10}\,4s^2\,4p^2$

Al – 13 $3s^2\,3p^1$

Si – 14, $3s^2\,3p^2$

→ $f(E)$ is the probability function of the electrons occupying a particular energy state E.

$$f(E) = \frac{1}{\exp\left[\frac{E - E_f}{K_B T}\right] + 1}$$

at $T = 0$

$E = E_f$

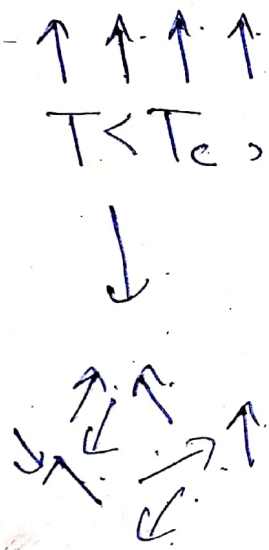
$$\boxed{f(E) = 1}$$

→ Inter-band transition: The transition b/w the conduction and valence bands

→ Intra-band transition: The transitions b/w the quantized level within the conductor or valence bands. It is also known as the inter-subband transition.

Diamagnetism: no-spontaneous magnetization. However, an applied field creates an induced magnetic field in them in the opposite direction, causing a repulsive force.

Curie Temperature: or Curie Point:



$T < T_c$, Permanent magnetic → Ferromagnetic

$T > T_c$, Paramagnetic

$T > T_c$ + applied magnetic field.

" The temperature above which certain materials lose their permanent magnetic properties