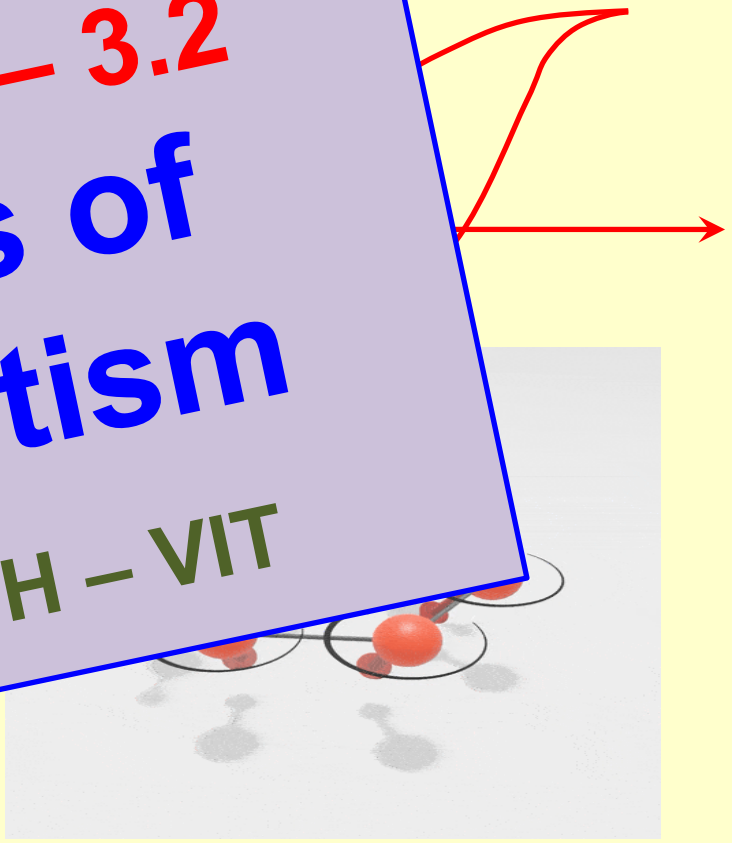
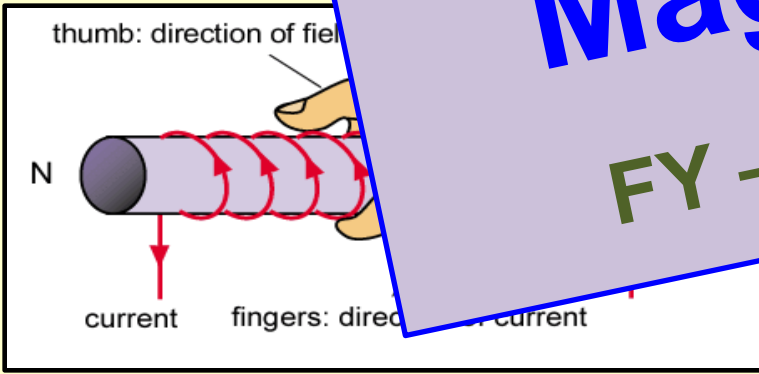


# Actuators – 3.2

## Basics of Magnetism

FY – DESH – VIT



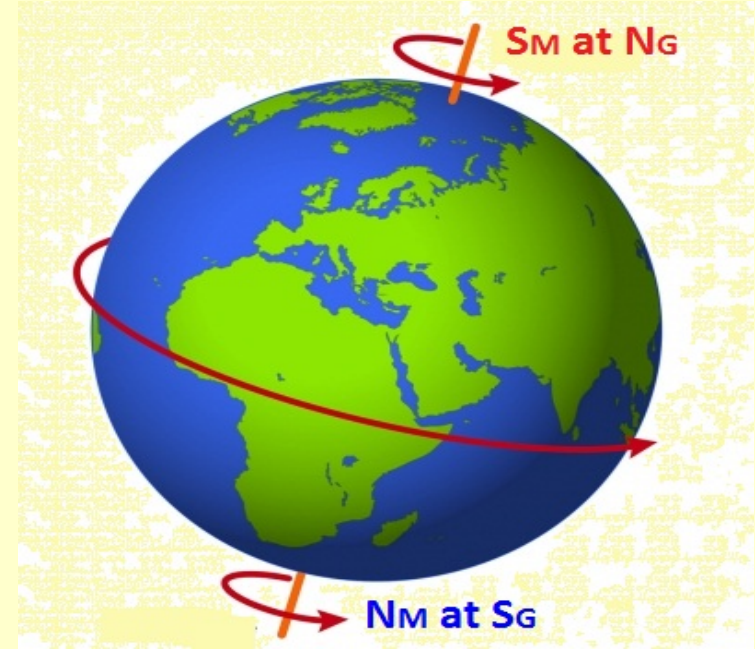
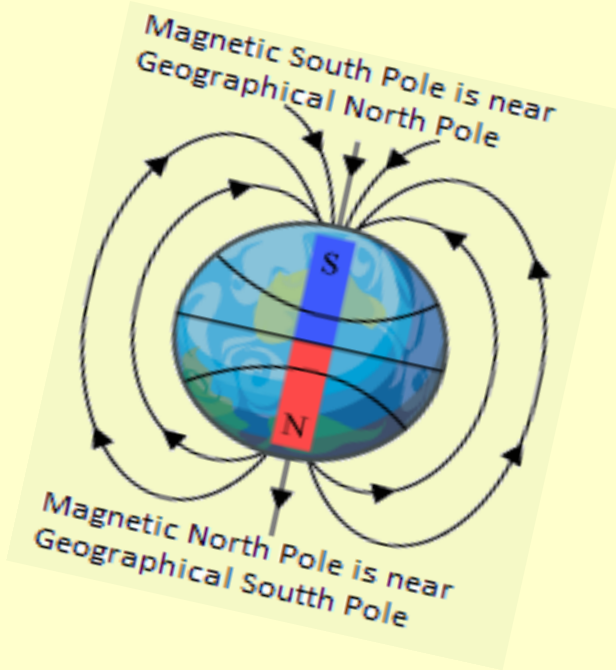
# The Earth – Magnetism - Poles



Try these questions –  
Just as a curiosity !

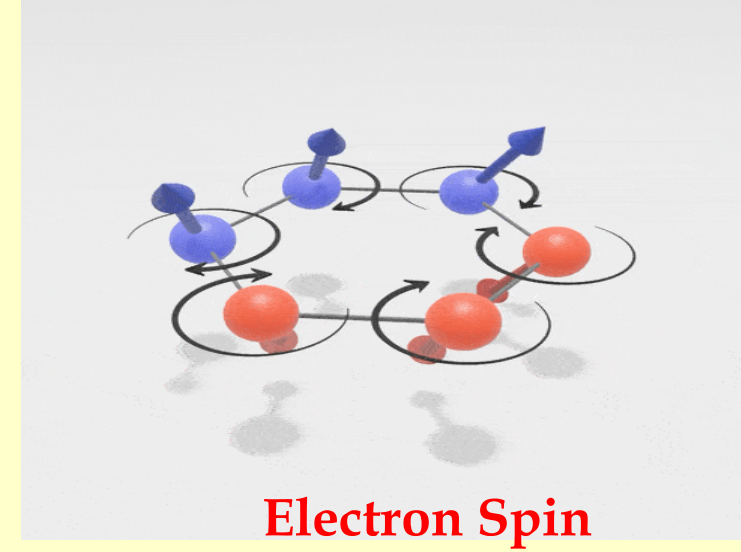
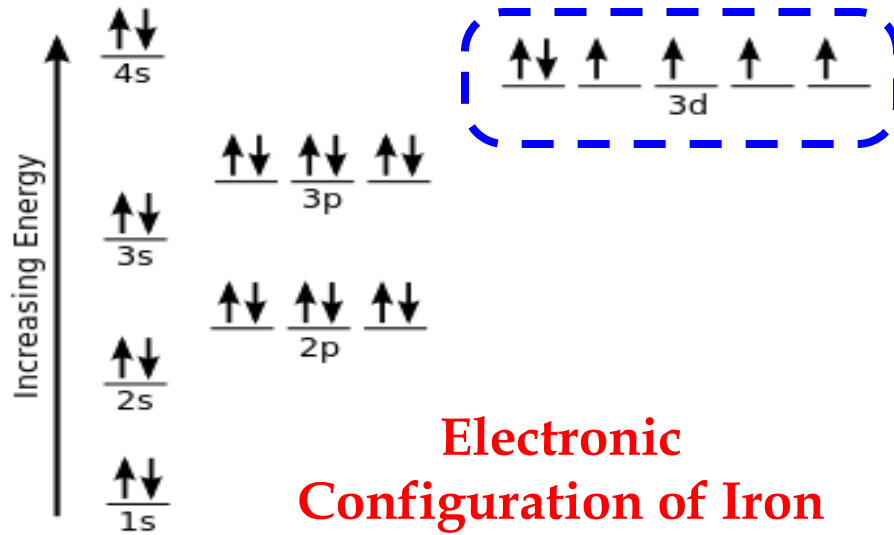
- Why the Earth shows Magnetic properties ?
- Where is Magnetic North Pole of Earth ?
- Where is the Magnetic axis ?
- Is Geographical axis same as Magnetic axis ?
- Are both axes matching ?
- What is the exact location of Magnetic Poles of Earth ?

# Earth as a huge Magnet .....



The Earth is a huge Magnet with its  
**Magnetic North pole at its Geographical South pole**  
and vice versa .....

# The origin of Magnetism

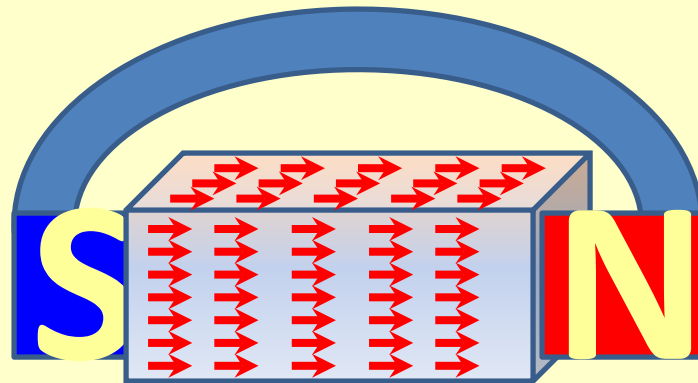
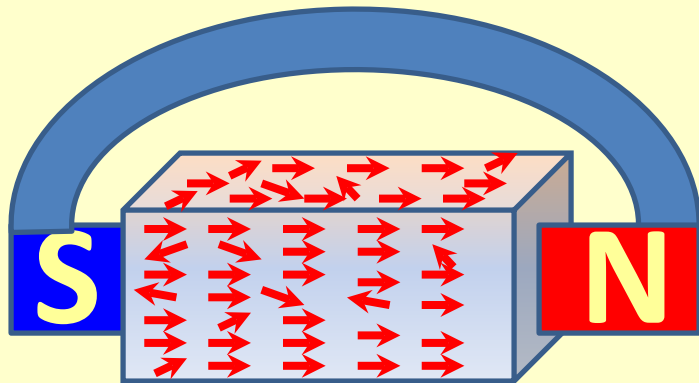
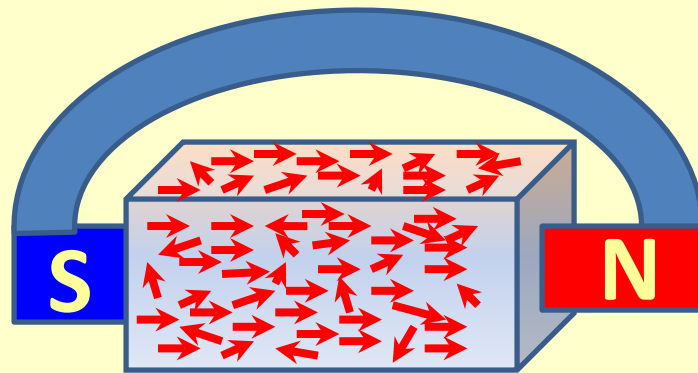
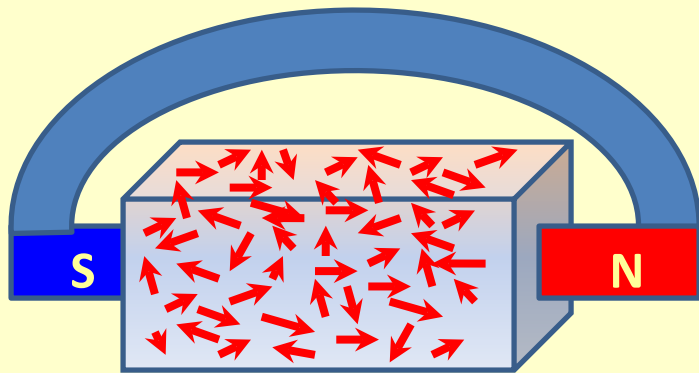


The number of unpaired electrons and their CW or CCW spins are mainly responsible for the Magnetism along with the crystal structure.

## Properties of Magnetic Lines of Force -

- 1) Magnetic lines are invisible, imaginary lines which are somewhat elliptical in shape which never cross each other.
- 2) Magnetic lines are closed loops that are supposed to travel from North pole of a bar magnet towards the South pole external to the magnet and from South pole towards the North pole internally.
- 3) Magnetic lines that are parallel and travelling in the same direction, REPEL each other.
- 4) Magnetic lines act like stretched rubber band which always try to contract.
- 5) Magnetic lines prefer a path of minimum reluctance.

# Concept of Orientation of Magnetic Flux in a material -



## Match the pairs

**A**

- 1) Left hand rule
- 2) Right hand thumb rule
- 3) Right hand rule
- 4) Right hand grip rule
- 5) Left hand screw rule
- 6) Fleming's Left hand rule
- 7) Fleming's Right hand rule

**B**

- A) Generating action
- B) Motoring action
- C) Direction of magnetic field due of current
- D) Magnetic attraction
- E) Lenz's Law
- F) Faraday's 2<sup>nd</sup> Law
- G) Faraday's 1<sup>st</sup> Law



Cross conductor



Dot conductor

**Will the two conductors attract or repel ?**

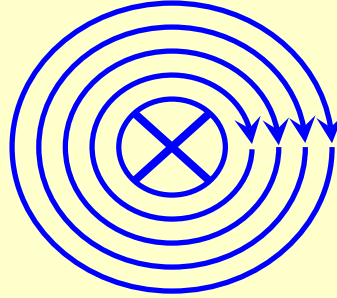


**.... And what about this ...?**

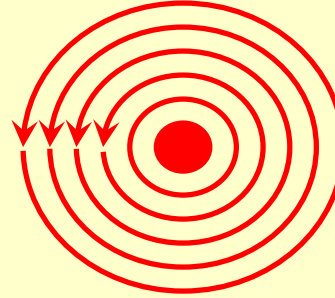


# Attraction or Repulsion is a property of the **direction of magnetic lines**

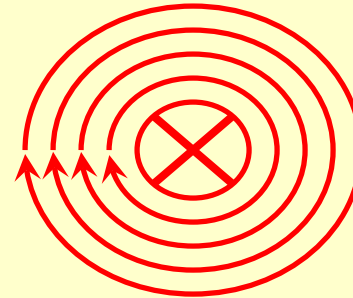
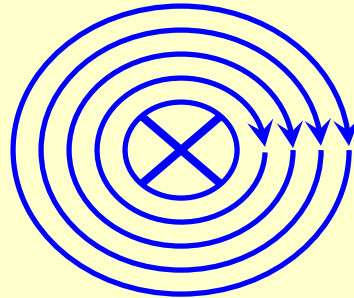
Cross conductor



Dot conductor

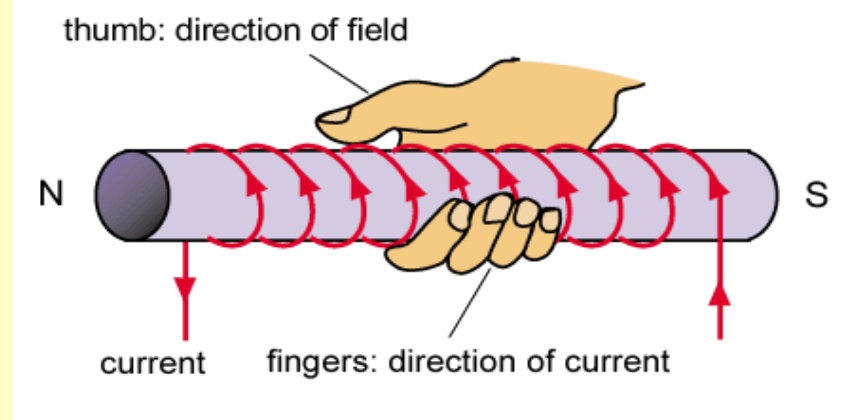
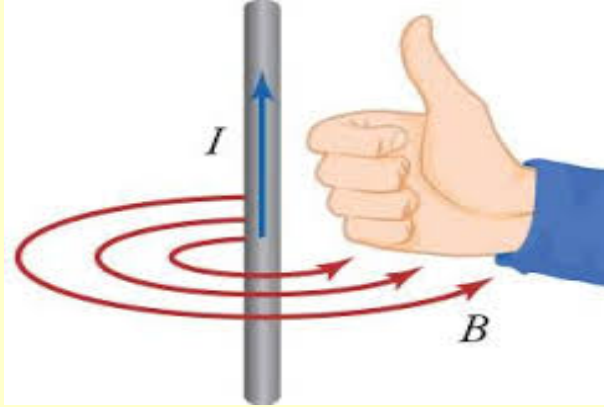


Lines that are travelling in the **same** direction will get **repelled** each other



Lines that are travelling in the **opposite** direction will get **attracted** each other

# Right Hand Thumb Rule



Which one of the above is correct ??

Thumb is for Current or Field ??



## Important terms related to Magnetism -

**Magnetic Permeability (  $\mu$  ) :** It is the property of a material to allow the magnetic line of force to pass through it.

**Unit is Henry per meter ( H / meter)**

**Relative Permeability :** It is just a ratio for comparison

$$\mu_r = \frac{\mu \text{ of the material}}{\mu \text{ of air or vacuum}} \quad ( \because \text{No unit} )$$

**A good ferromagnetic material is about 800 to 1200 times better than air. *Value of  $\mu_r$  for air = ??***

## Important terms related to Magnetism -

**Magneto Motive Force MMF ( F ) : (Similar to EMF)**

**F = No. of Turns x Current through them**

**F = N x I Unit = Amp-Turns (OR Amp)**

**Magnetic Flux Density ( B ) :**

$$B = \frac{\text{Flux}}{\text{Area}} \quad \text{Unit is Tesla ( T )} = \frac{\text{Weber}}{\text{Sq. meter}}$$

**Magnetic Field Strength OR**

**Magnetic Field Intensity OR**

**Magnetising Force ( H ) : MMF reqd. per meter length**

**Unit is Ampere-Turns per meter ( Amp / meter)**

# Important terms related to Magnetism -

$$\text{Flux } (\phi) = \frac{\text{MMF (F)}}{\text{Reluctance (s)}} = \frac{\text{Amp} \times \text{Turns}}{(1/\mu) \times (\ell/a)}$$

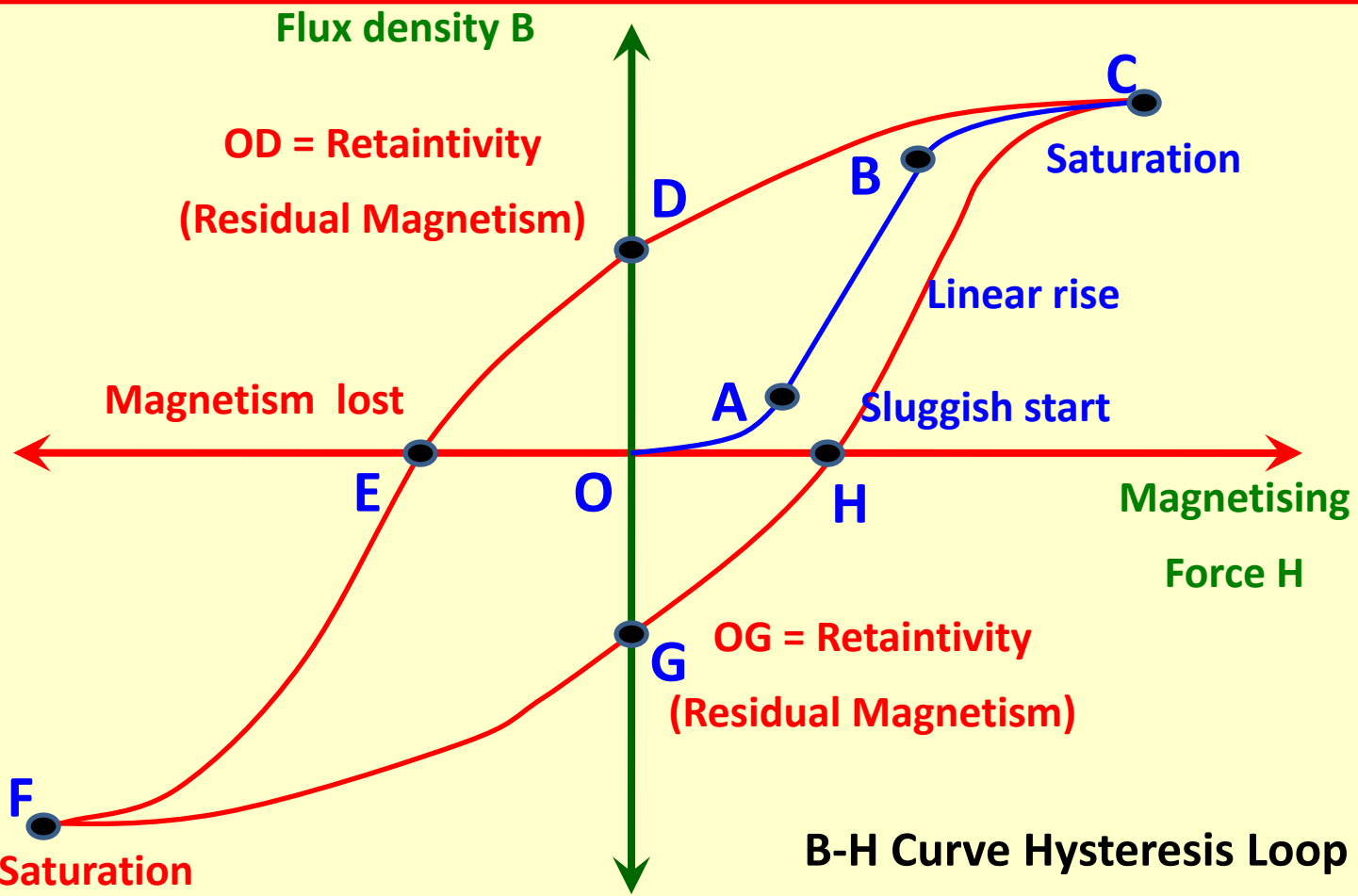
$$\text{Flux } (\phi) = \frac{I N}{(1/\mu) \times (\ell/a)}$$

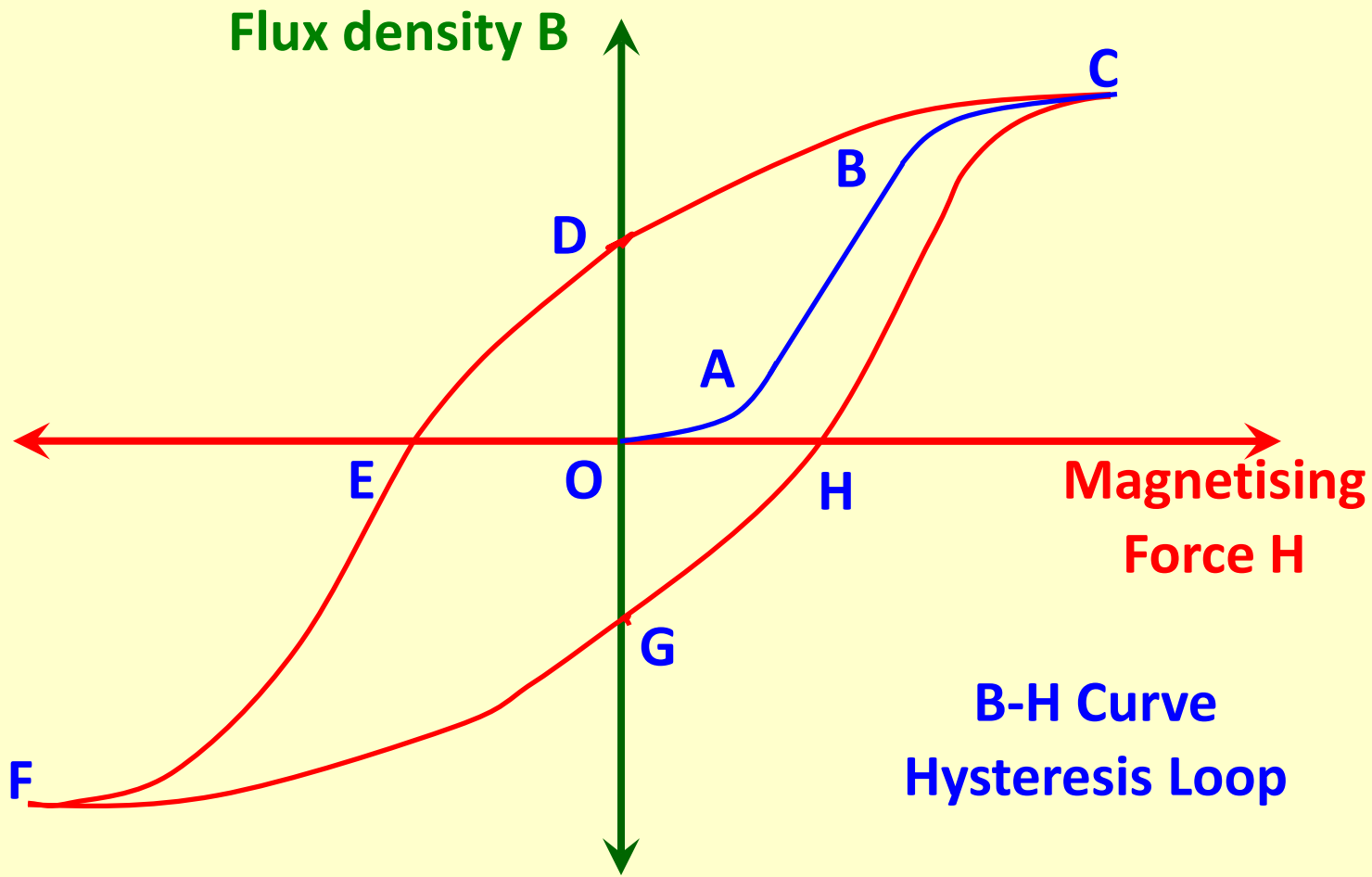
$$\text{From above we get, } \mu = \frac{\phi \ell}{I N a}$$

We know that,  $H = B/\mu$

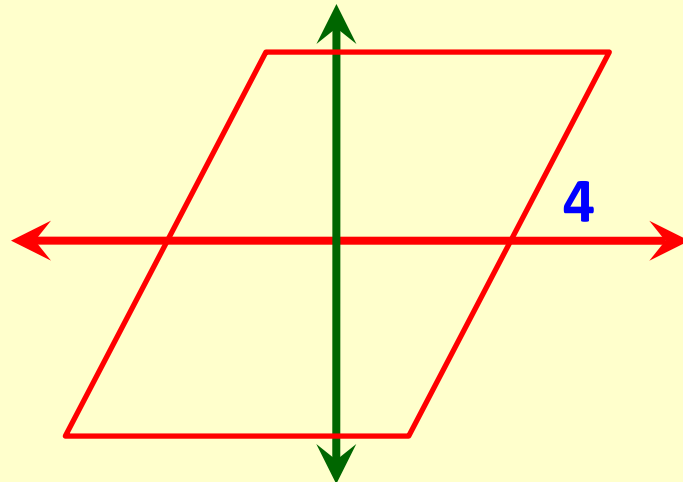
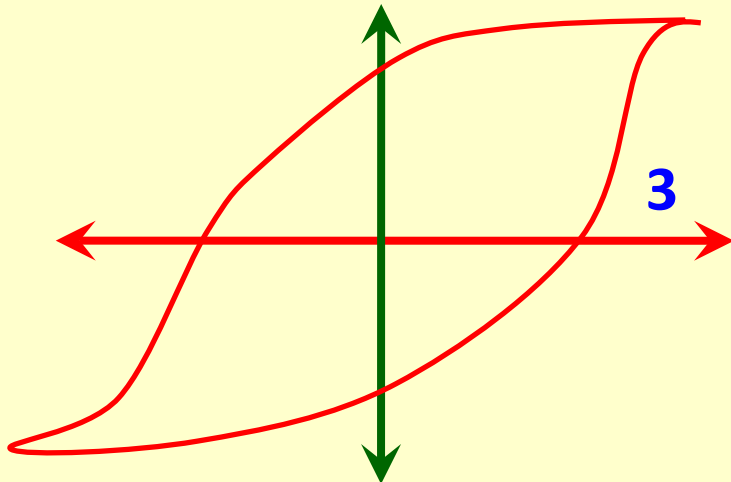
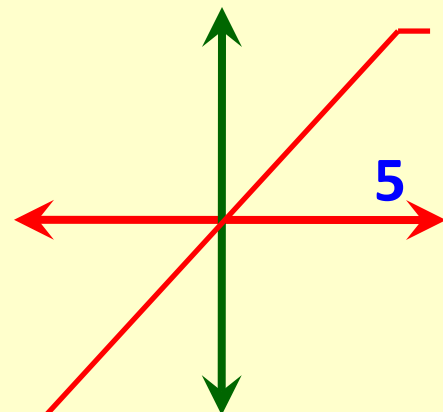
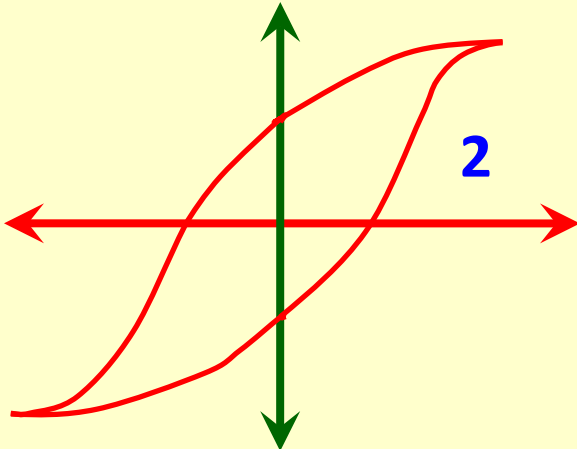
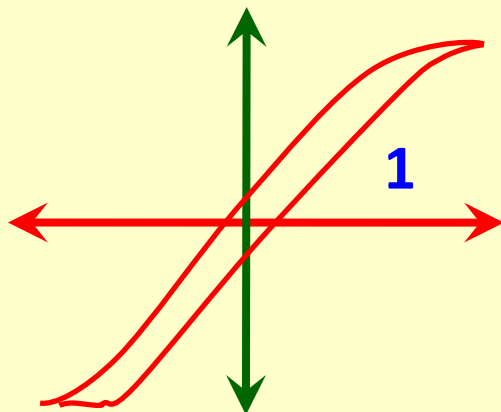
$$\text{Substituting for B and } \mu, \quad H = \frac{\phi}{a} \times \frac{I N a}{\phi \ell} = \frac{I N}{\ell}$$

Thus, H is a function of the Current I which produces the  
Flux  $\phi$  .....  $H \propto I$



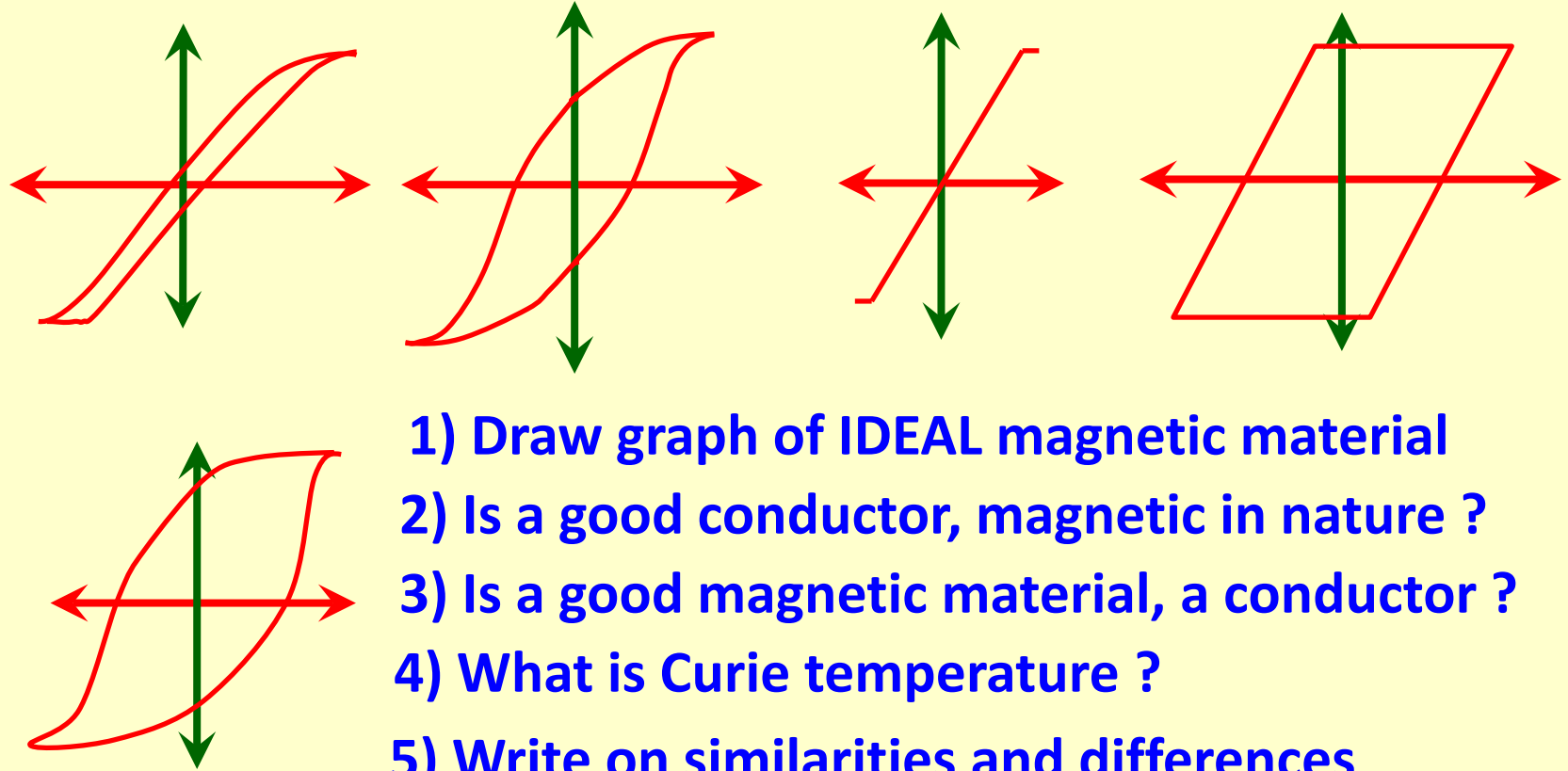


# Comment on all the curves -

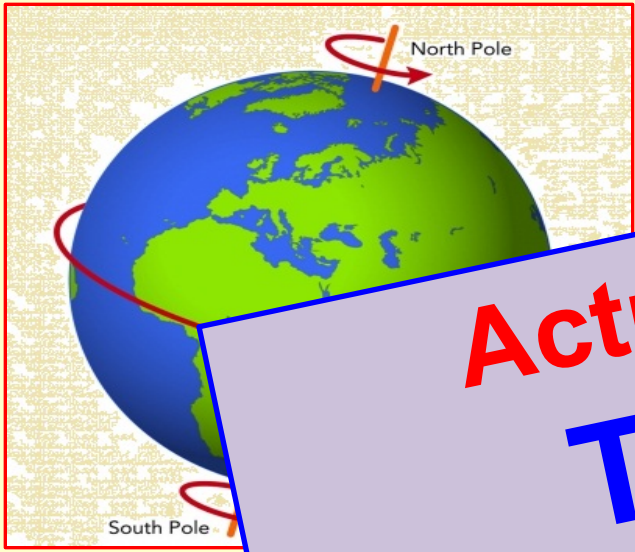




## Home work –



- 1) Draw graph of IDEAL magnetic material
- 2) Is a good conductor, magnetic in nature ?
- 3) Is a good magnetic material, a conductor ?
- 4) What is Curie temperature ?
- 5) Write on similarities and differences between Electrical and Magnetic circuits



**Actuators – 3.2**  
**Thanks !**  
**Basics of Magnetism**  
**FY – DESH – VIT**

