Engineering Physics Laboratory
(Course Code : PHY119)

Experiment - 3

AIM: To determine the Hall voltage and Hall coefficient by using Hall effect.

Learning Objectives

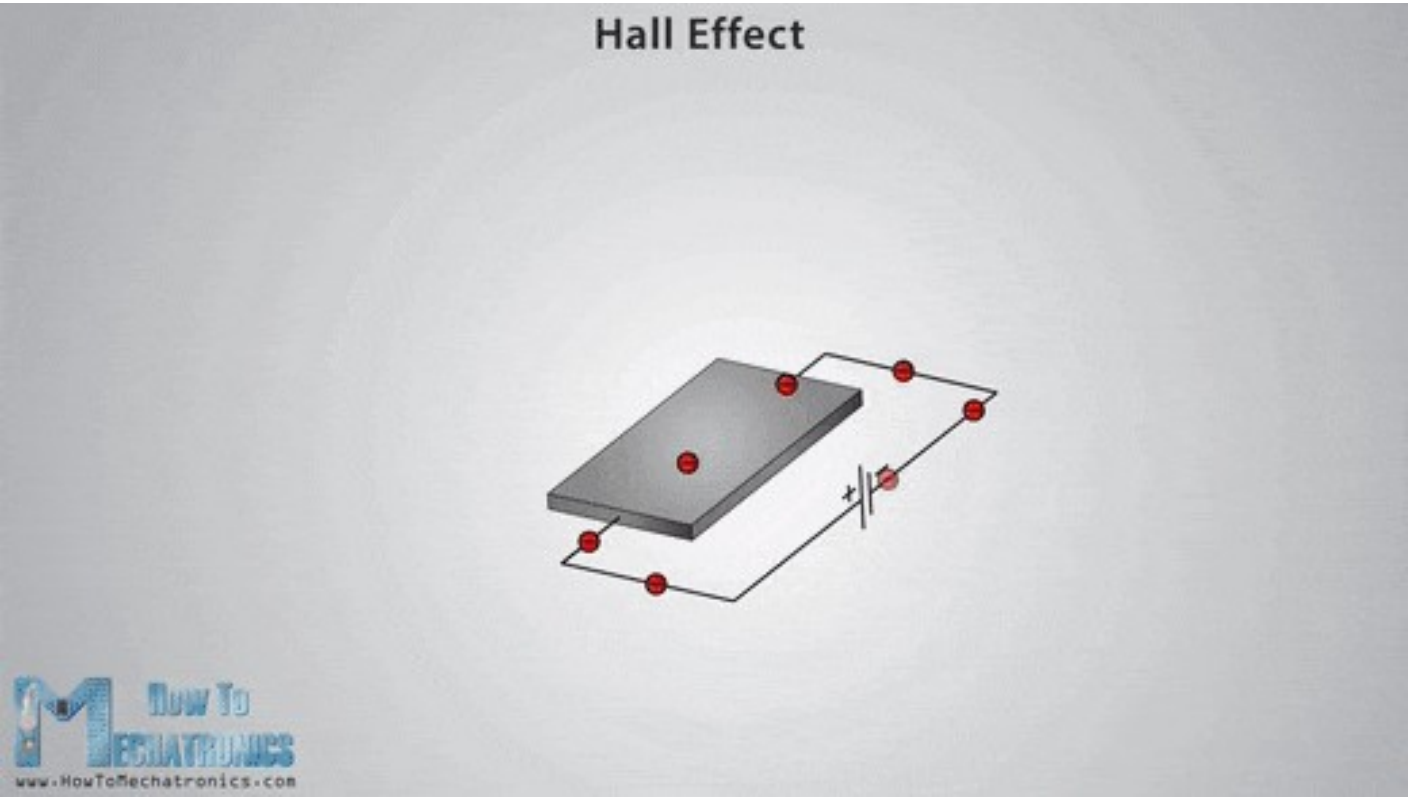
1. To understand new phenomenon called Hall effect.

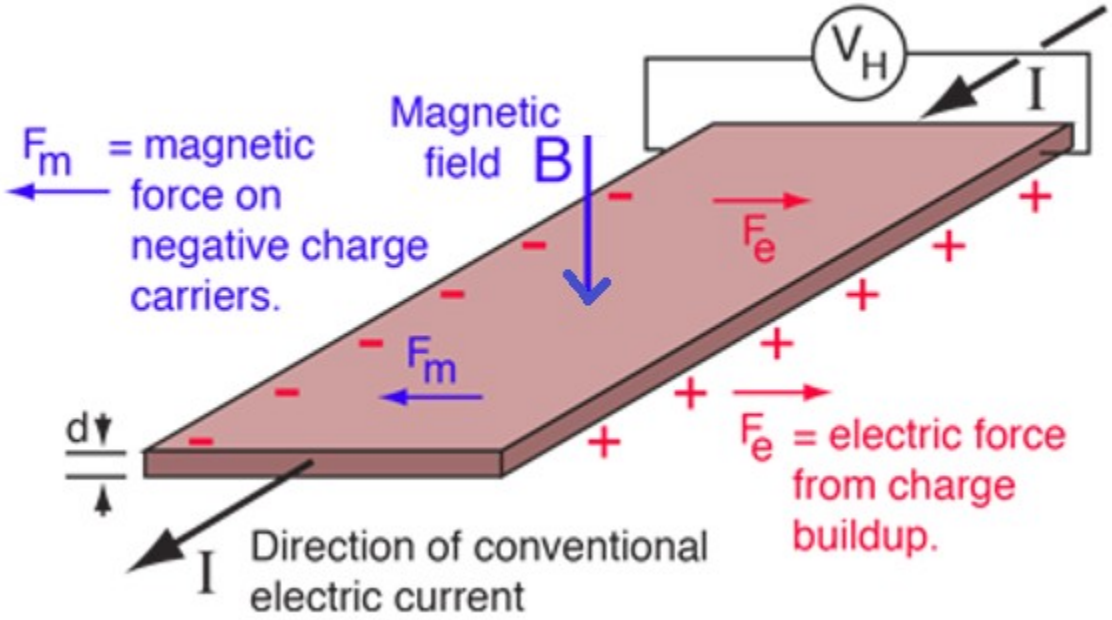
2. Variation of Hall voltage with magnetic field keeping current through specimen fixed and vice-versa.

3. To calculate various parameters of the given material like number density, mobility etc.

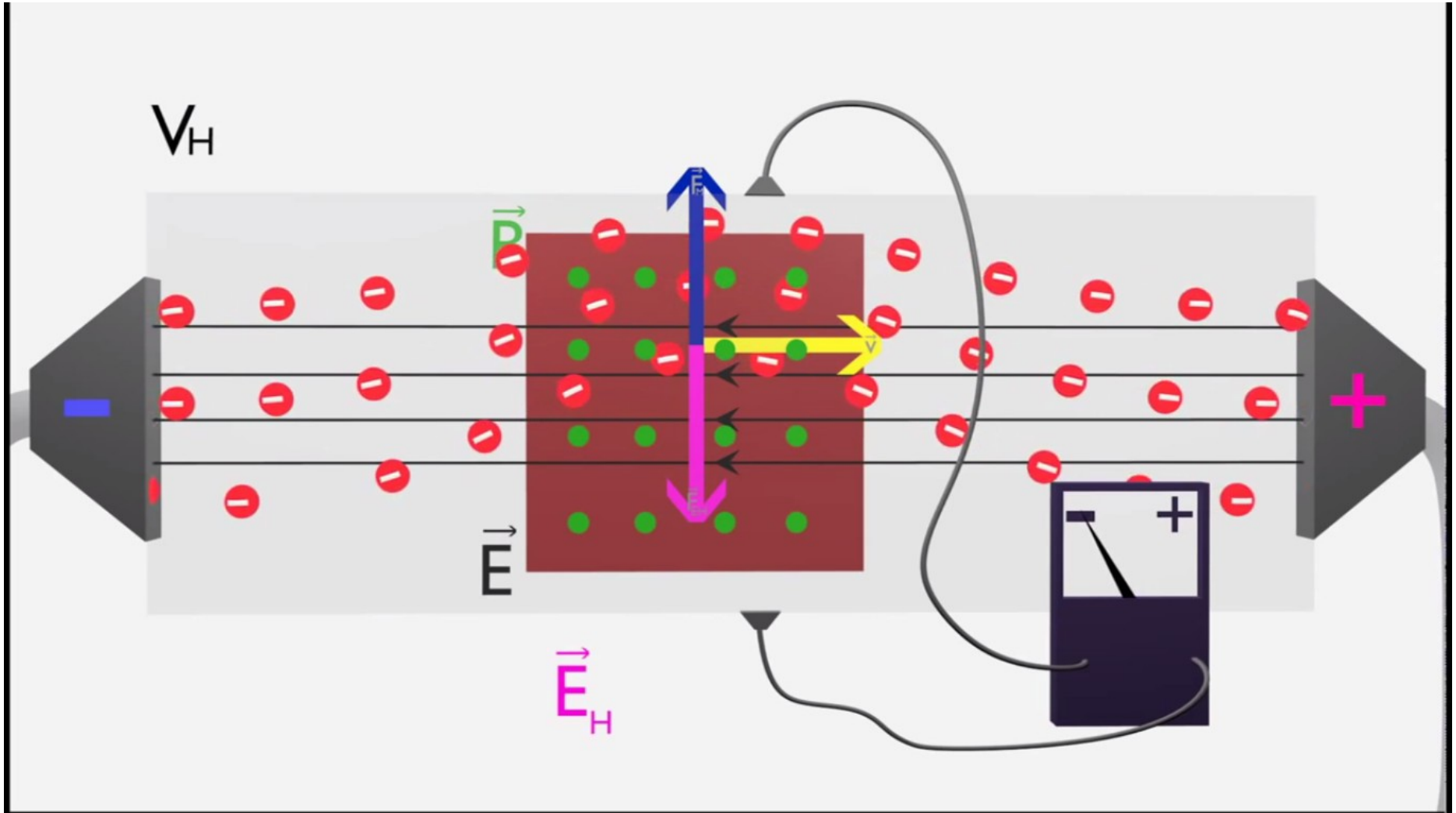
LET US START

HALL EFFECT


Hall Effect
How To Mechatronics
www.HowToMechatronics.com


V_H
I
Magnetic field B
F_m = magnetic force on negative charge carriers.
F_e
F_m
d
F_e = electric force from charge buildup.
I
Direction of conventional electric current

LORENTZ FORCE (Click)



$F_B = Bqv$

$F_E = Eq$ but $E = \frac{V_H}{d}$

$F_E = \frac{V_H q}{d}$

So if $F_B = F_E$

$Bqv = \frac{V_H q}{d}$

$V_H = Bvd$ = Hall Voltage

Hall effect is a very useful phenomenon and helps to

✔ Determine the Type of Semiconductor

By knowing the direction of the Hall Voltage, one can determine that the given sample is whether n-type semiconductor or p-type semiconductor. This is because Hall coefficient is negative for n-type semiconductor while the same is positive in the case of p-type semiconductor.

✔ Calculate the Carrier Concentration

The expressions for the carrier concentrations of electrons (n) and holes (p) in terms of Hall coefficient are given by

$$n = \frac{1}{qR_H} \quad and \quad p = \frac{1}{qR_H}$$

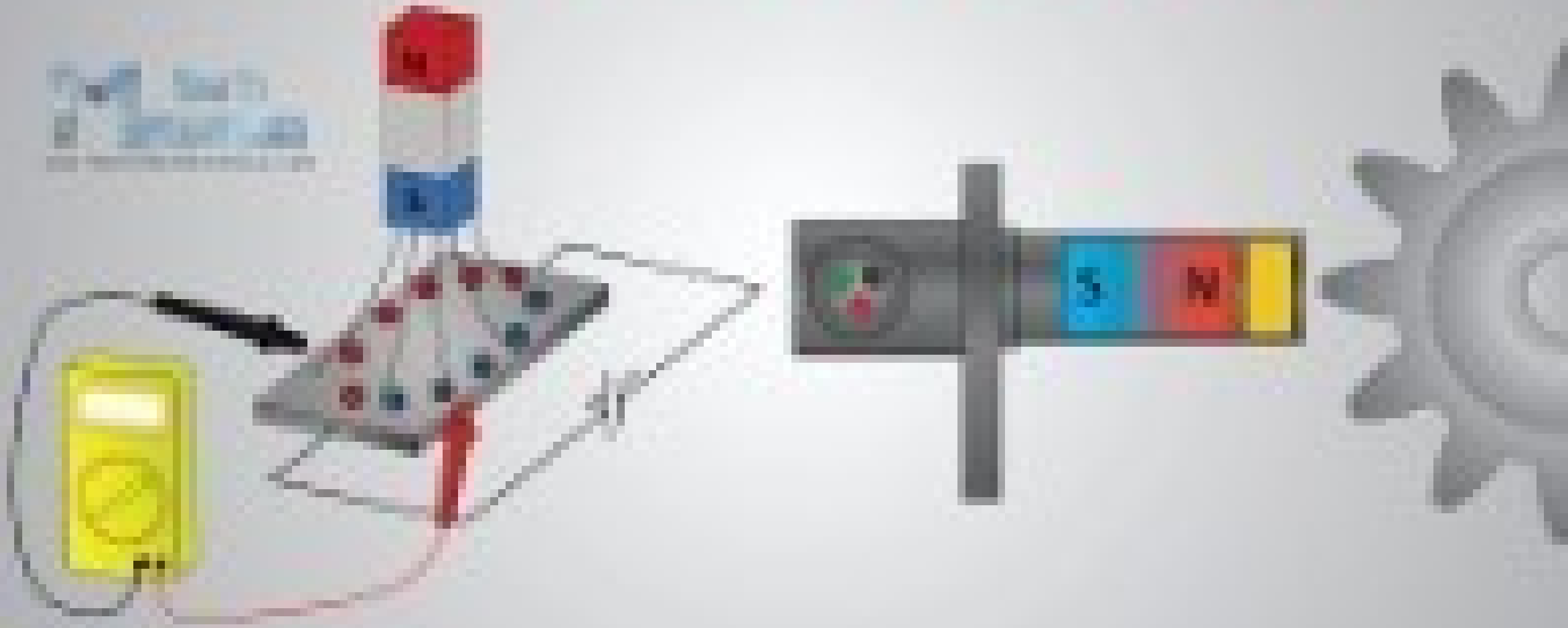
✔ Determine the Mobility (Hall Mobility)

Mobility expression for the electrons (μ_n) and the holes (μ_p), expressed in terms of Hall coefficient is given by,

$$\mu_n = \sigma_n R_H \quad and \quad \mu_p = \sigma_p R_H$$

A video illustrating Hall effect and its applications

Hall Effect



Check your understanding

Check your understanding

Q

Q3.1: In the Hall Effect, the directions of electric field and magnetic field are parallel to each other.
The above statement is

a) True

b) False

Check your understanding

Q

Q3.2 : Which of the following parameters can be found with Hall Effect?

a) Polarity (n or p-type)

b) Conductivity

c) Carrier concentration

d) All of these.

Check your understanding

Q

Q3.3: In the Hall Effect, the electric field is in x direction and the velocity is in y direction. What is the direction of the magnetic field?

a) X

b) Y

c) Z

d) XY plane

Check your understanding

Q

Q3.4: In Hall effect, the force responsible for the separation of charge carriers which results in Hall voltage is

a) Coulomb force

b) Gravitational force

c) Lorentz force

d) Nuclear force

Check your understanding

Q

Q3.5: In Hall Effect, the electric field applied is perpendicular to both current and magnetic field?

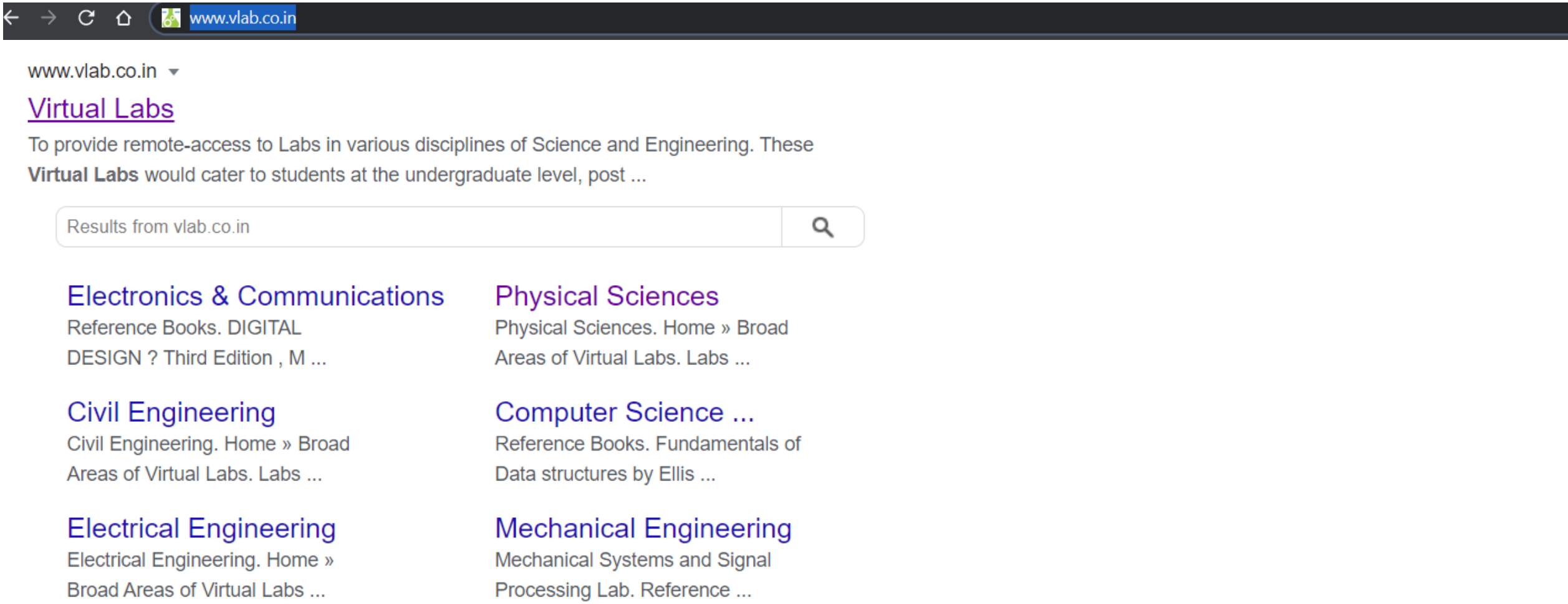
a) True

b) False

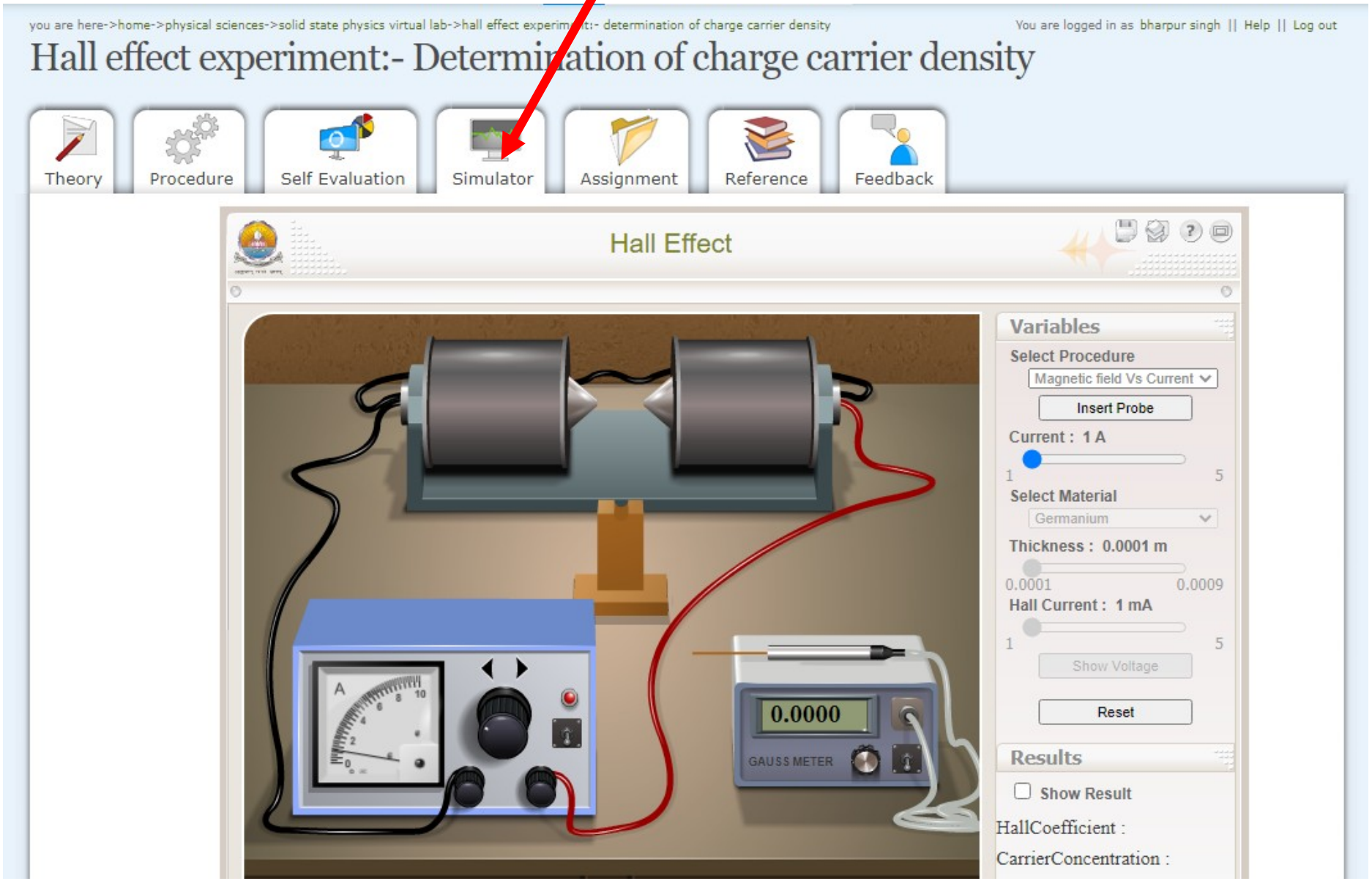
Step by Step guide to perform the experiment in Virtual lab

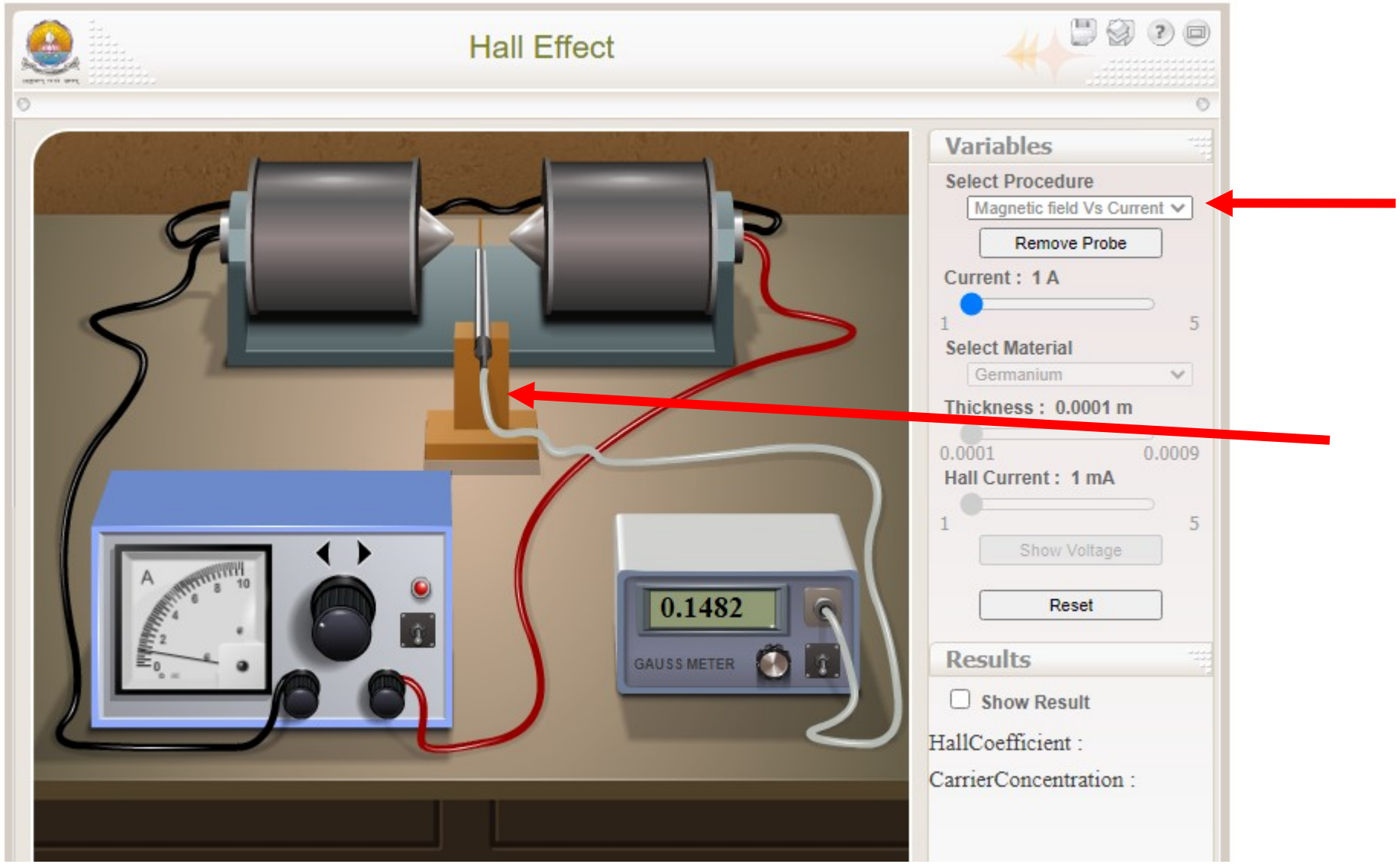
Follow the slides below.

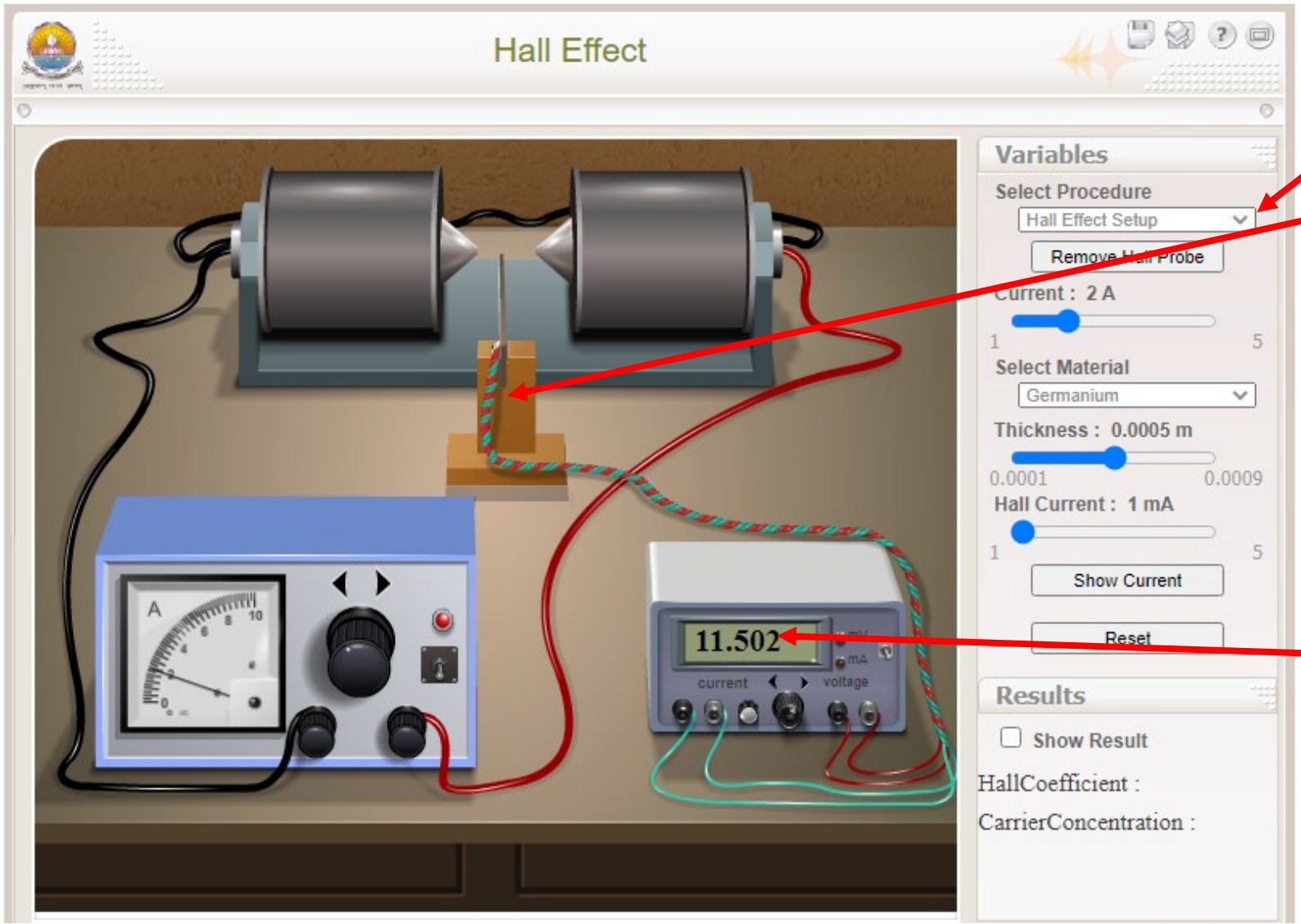
Type this link on the address bar or Click on this link : https://www.vlab.co.in/



Click on the simulator




Hall Effect
Variables
Select Procedure
Magnetic field Vs Current
Remove Probe
Current : 1 A
1
5
Select Material
Germanium
Thickness : 0.0001 m
0.0001
0.0009
Hall Current : 1 mA
1
5
Show Voltage
Reset
Results
Show Result
HallCoefficient :
CarrierConcentration :
0.1482
GAUSS METER
A


Hall Effect
Variables
Select Procedure
Hall Effect Setup
Remove Hall Probe
Current : 2 A
1
5
Select Material
Germanium
Thickness : 0.0005 m
0.0001
0.0009
Hall Current : 1 mA
1
5
Show Current
Reset
11.502
current
voltage
Results
Show Result
HallCoefficient :
CarrierConcentration :

Activity Based Polling

while the students perform the experiment in virtual lab

A

A3.1: Measured value of the magnetic field when current of 3.5 amperes passes through the electromagnet is

a) 0.5188 Tesla

b) 34.507 Tesla

c) 5.188 Tesla

d) 0.34507 Tesla

A

A3.2: Measured value of the Hall voltage for germanium sample, when a current of 2 mA passes through it and placed in perpendicular magnetic field of 0.4447 Tesla. Take thickness of the specimen to be 0.5 mm.

a) 22.607 mV

b) 34.507 mV

c) 2.2607 mV

d) 3.4507 mV

A

A3.3. Calculate the carrier concentration for semiconductor (Ge) of thickness 0.3mm. (As per simulator)

a) 3.22 X 10^20

b) 4.55 X 10^20

c) 6.55 X 10^20

d) 2.46 X 10^20

Check your understanding

Q

Q3.4: Calculate manually the Hall Effect coefficient when number of electrons in a semiconductor is 10^{20}.

a) 0.625

b) 0.0625

c) 6.25

d) 62.5