Program T Y B  Sc Subject physics

Semister 6th

Course code.PYC 109

Section two Instrumentation

Course title :-solid state

devices and instrumentation.

Unit 1  instrumentation

module name is

**linear variable differential transducer.**

**And Hall effect transducer.**

Good morning students.

I'm going to explain you linear variable

differential transducer (LVDT) and

hall effect transistor.

Outline of this course is.

Linear variable

differential transducer

and hall effect transducer.

Learning outcomes.

The students will be able to.

Explain the operating principle of

linear variable differential transducer.

And. Students will be able to explain

Hall effect and its application.

Let me to start the first one, **linear**

**variable differential transducer.**

The differential transformer is

a passive inductive transformer.

The basic construction of LVDT is as shown.

You can see the construction availability.

This is a frame.

Exactly in the middle there

is a primary winding.

And besides primary winding,

there are two windings,

secondary winding one

and secondary winding 2.

It is a hollow cylinder.

In the hollow space,

soft Iron Core is put and it is movable. Number of turns in

the primary winding is more than the number

of turns in the secondary windings .

If there are 4500 windings in the primary,

then the number of turns in

the secondary 1 is 3500.

Also number of turns in the

secondary 2 will be 3500.

The transformer consists of a single

primary winding P1 and two secondary

windings S1 and S2 which is bound

on a hollow cylindrical former.

You can see here  S1 and S2.

Besides primary winding.

The secondary of the transformer

have equal number of turns and

identically placed on either

side of the primary windings.

The primary winding is

connected to an AC source.

You can see in the diagram the primary

winding is connected to an AC source.

So two ending two secondary windings

are connected in series and the

core  i. e the ferrite core or nickel

alloy core is placed exactly in

the middle of the two windings.

The movable soft iron core slides within

the hollow former and therefore it

affects the magnetic coupling between

the primary and the two secondaires.

The displacement which is

to be measured is applied to the

arm attached to the soft iron core.

Actually,

the core is made up of nickel iron

alloy which is slotted longitudinally

to reduce the Eddy current losses.

We can see that, there is a soft iron core

you can move forward or move backward.

Primary AC input is connected and to the

secondary you can check the voltages at each winding.

When the core is at the normal

position that is at the null position,

then equal voltages are induced

into the secondary windings,

so you can see that,.

if the soft

iron core is exactly in the middle,

the voltage across the secondary 1

is exactly equal to

the voltage across the secondary 2

that is called as the null position.

You can see here when the core is

normal position that is null position,

then equal voltages are induced

in the two secondary windings.

The frequency of the AC input voltage

applied to the primary winding

ranges from 50 Hertz to 20 kilohertz.

The output voltage of the secondary

winding S one is VS1 and that of

the secondary winding S2 is VS2.

In order to convert the output from

S1 & S 2 into a single voltage,

the two secondary S1 and S2 are

connected in series that is as shown.

You can see here that is as shown,

you can see.

Then the output voltage of the transducer

is the difference of the two voltages.

Therefore the differential

output voltages be not.

That is, V output is Y is equal to.

VS1 is nearly equal toVS2.

It is at normal position.

The flux linking with

both secondary is equal.

Therefore voltage induced in both

winding is same  hence at null

position that is called as a VS1

is exactly equal to VS2 since the

output voltage of the transducer is

the difference of the two voltages,

the output voltage is zero at null position.

Now, if the core is moved to

the left of the null position,

more flux links with winding S

one and Less   with winding S2.

Hence the output voltage VS1

of the secondary winding.

S1 is greater than VS2.

The magnitude of the output voltage.

of the secondary VS 1 - V

S Two is in phase with VS1.

Similarly, if the core is moved

to the right of the null position,

the flux linking with the winding

S2 becomes greater than the

link with winding S one.

Hence VS2 becomes greater than VS1.

The output voltage in this is

V output is equal to V 2 -

V S One it is in phase with VS2.

If the amount of voltage change in

the secondary winding is proportional

to the movement of the core.

Here you can see the output voltage

of the is a linear function of the

core displacement or various position

of the core diagram shows the three

different positions of the core.

See if the core is at the left position

VS1 is there greater than VS two.

If the core is exactly in the center.

VS1 is exactly equal to VS2 that

is called as a null position if

the core is at the right position.

V S2 is greater than BS1.

In figure P that I have shown,

the core is at 0,

which is central zero or null position.

Therefore VS one is equal to VS2

Voutput is zero .When the core is at the left.

That is, as shown in the figure.

Here, VS1 is more than VS2,

that is V S1 - V S 2 is positive

when the core is at the right.

That is as shown in the figure.

See here.

VS1 is less than we have two that

is VS 1 - V S 2 is negative.

Advantages of LVDT?

First one**- linearity** The output

voltage of the transducer is

practically linear for displacement.

Second one:- infinite resolution,

third one:- high output and 4th

one is high sensitivity.

Disadvantages of LVDT first one

large displacements are required

for appreciable differential output.

Second,

one L are sensitive to stray magnetic fields.

Third,

one temperature affects the transversal.

Example,

if you're solving the problem on LVDT,

you can see here there is a problem

and LVDT has an input voltage.

Primary VP is equal to 6.3 Volt.

Output voltage is 5.2 Volt for the

range of plus or minus 1.6 centimeter.

Then calculate the output voltage

for core position going from plus .50

centimeter to minus .35 centimeter.

Second one,

the output voltage when the core is

at minus 30 position.

So solution.

1.6 centimeter displacement produces

the output voltage of 5.2 Volt,

then 5 centimeter and

.35 centimeter produces how much

voltage you can calculate this first

one point 50 centimeter into 5.2

centimeters divided by 1.6 is equal

to plus or minus 1.625 seconds.

1 -- .35 centimeter into 5.2 /.

1.6 centimeter is equal to minus of 1.137.

For output voltage is equal to

minus .3 centimeter into 5.2 /

1.6 this is equal to 0.976 volts.

Hall effect

what is Hall effect? when a magnetic

field is applied to a current carrying

conductor in a direction, Perpendicular to that of flow of current.

A potential difference or transverse electric

field is created across the conductor.

This phenomena is known as hall effect.

If a metal or semiconductor carrying a

current I is placed in a uniform transverse

magnetic field .An electric field,

is induced perpendicular to both I and B

Then this phenomena is known as hall effect.

You can see the diagram Hall

effect diagram here. This is a.

Metal or semiconductor.

This is a metal or semiconductor

you can see here.

This is a semiconductor side one and

side two. hear if a current of a metal

or semiconductor carrying a current

I is placed in a transverse magnetic

field B and induced electric field E

is applied perpendicular to both B

and I is known as the hall effect.

You can see the diagram here.

Consider a figure shown over here.

The current I is in the positive X direction.

Magnetic field  B is in the positive

Z direction.

Then,induced electric field will be

in the negative Y direction.

You can see there in the diagram.

Hey current I may be due to the

holes moving from left to right

or electrons moving from right to

left in the semiconductor specimen.

The carriers, either electrons or holes.

It depends on the semiconductor

Is n type and type or P type.

If the semiconductor is of n type,

then the current is carried out by electrons.

These electrons will accumulate on side

One and the surface will become negatively

charged with respect to side two.

You can see your side one and side 2.

The voltage appears between side one and

side two is called as the hall voltage.

Mathematical expression for hall effect.

Measurement of Hall voltage hall coefficient.

Mobile team, you and Hall angle Phi.

Under steady state condition,

the force exerted on the charge carriers

due to the electric field generated due

to Hall Effect will balance the magnetic

force exerted on charge carriers due

to the magnetic field that is e.

Into EH is equal to B into e

and velocity of the.

Particles, where is the magnitude of

the charge of the electrons or holes.

B is the drift velocity.

You can see there P is that after listening.

But electric field EH is equal to haul BV,

but is the distance between the two plates.

Here D is the distance between surface

one and Surface 2 from equation one,

VH is equal to H in 2D and from from

equation to VH is equal to H in 2D and

from equation 1E H is equal to be into P.

Heathrow is a charge density and

is the width of the specimen then.

Drift velocity V is equal to I

upon grow into into D,

substituting equation four and five in

equation three we get hall voltage VH

is equal to B dot V dot D is equal to

be into I divided by rho into into the.

Into DDD is getting cancelled and

hall voltage VH is equal to be

into I divided by rho into.

That is we can write as charge

density rho is equal to.

VHP into I / V H into West.

From equation 7 the value of charge

density can be determined if we

know the values of B magnetic

field BI is the current hall

voltage and width of this specimen.

Here the current density is

J is equal to I told by east.

So I divided by West into D that is

charge density rho into drift velocity.

Hall coefficient the hall coefficient

can be defined as the hall field per unit

current density per unit magnetic field is.

Mathematically,

it can be written as hall coefficient.

RH is equal to electric field due to

the hall effect divided by current

density into magnetic field that

is equal to EH by J.

Crosby is equal to BHY D / J cross B.

Hall coefficient RH is equal to be

into aidoru into into high divided by.

D into J into P that is equal to

I divided by rho into into D into

J that is equal to 1 upon.

Row because I is equal to.

DJ that is getting cancelled with

AI that is equal to 1 up on north.

ITA into east that is VH into West by

B into I4 in extrinsic semiconductor,

the current carrying charge per

user of one type,

either electrons or whole like an N type.

The charge carriers are electrons

and in P type.

Semiconductor,

they charge charge carriers are holes.

The conductivity Sigma is given as

Sigma is equal to charge density

rho into the into MU MU is equal to.

Conductivity Sigma divided by charge

density one upon rho is equal to

hall coefficient RH.

Therefore,

MU is equal to rho into Sigma into RH.

MU is the mobility,

Sigma is the conductivity and RH is

the hall coefficient. Whole angle.

The resultant electric field due

to the due to electric field in X

direction EX and hallfield acting

in wire direction.

Each,

the resultant electric field east

makes some angle with electric

field in X direction EX.

This is called as the whole angle.

You can see the diagram hall angle Phi H.

High level fire is equal to 10.

Universe of.

EH,

Pi XH is equal to VH YD electric

field component in X direction

can be written as X is equal to

voltage drop along the length

divided by length of the specimen.

That is equal to π R by.

L so I enter resistivity into

L / L into east.

That is L is getting cancelled.

I divide by a into resistivity.

That is, X is equal to J into.

I buy Sigma,

substituting the value of X&YH

in the expiration of Hall's angle

we can get hall angle.

We can get 5H is equal to tan

inverse of each by X hall angle

Phi is equal to tan inverse VH

by divided by J interrow.

Flow is the charting city,

Chi Sigma is the conductivity

and J is the current density.

Applications of Hall effect.

To determine polarity.

It is used to determine the

type of semiconductor that

is either N type or P type.

It is used to determine either

determine carrier concentration.

It is used to determine the

electrons and holes concentration.

Third one to determine conductivity.

Hall effect use is used to find

conductivity of the material and mobility.

Port one to measure the

displacement and current.

It is used for the measurement

of displacement and current

in mechanical sensors.

Fifth one to measure power.

Power measurement is an

electromagnetic wave can be done

with the help of Hall effect.

References and acknowledgements.

References used is HLC electronic

instrumentation by TH edition.

Thank you.