

Module IV

FORCE, TORQUE AND SOUND (F)

\Rightarrow Hall Effect (H) =

- * It is a type of (E) which is used for measuring the mag field intensity.
- * H.E (E) converts mag field into an electric vol. which can be easily measured by an analogue voltmeter.

principle →

- * If the cont carrying cond is placed with in a mag field, then vol is developed across the coil of cond.

$$F_H = (k_H B l) I t$$

$k_H \rightarrow$ H. E (cof)

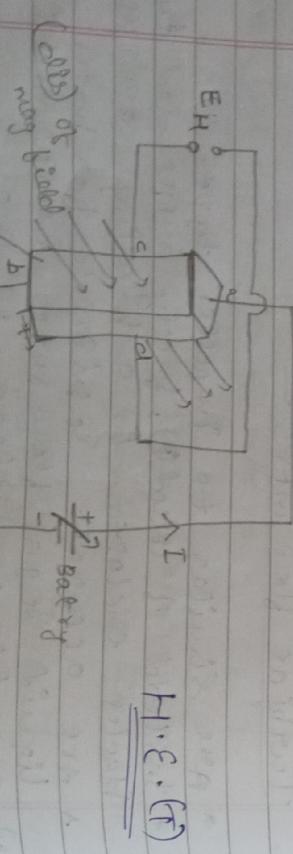
B → mag field intensity

I → current through the cond

t → thickness of cond.

This phenomenon of a cond \rightarrow H.E.

- * It is mainly used for mag intensity.



(obj) of hall
mag field

cont'd

187 →

0001 0001

obj

mag field

cont'd

analog

signals

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Applic.

- * motor control devices
- * Robotics

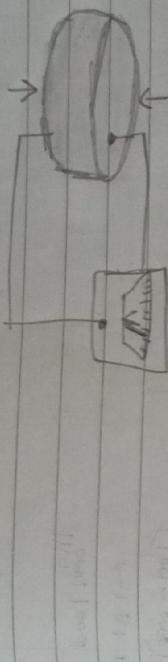
(2) Eddy current (E.C.) =

Principle →

- * An E.C. is caused by a moving mag field intersecting a cond. vice-versa.
- * Relative motion causes a circulating flow of electrons in cond. with in the cond.
- * The stronger the mag field greater the electrical conductivity of the principle.
- * Conductivity of the cond., thus greater the cms opposing force.

(3) Piezo-electric Sensors =

- * It is a device that uses the P.E effect, to measure changes in pressure, acceleration, temp., strain, force by converting them to an electrical charge.
- * Containing P.E. ionic crystal materials like quartz.
- * On applying force / pressure, these materials get stretched / compressed.

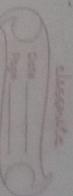


(4) Tachogenerators =

- * Device used to measure speed of a shaft in terms of voltage.
- * Used to measure the speed of electric motor, engines, micrometers, etc.
- * 2 types →
 - a) DC tacho (G) =
 - b) AC tacho (G) =
- * It is a small DC generator which generates voltage corresponding to speed of a machine. When the shaft of machine rotates, the armature of tacho rotates in the mag field producing voltage which is proportional to the product of flux & speed to be measured.

principle →

- The way a P.E material is cut produces
- 3 main operational modes.
 - 1) Transverse
 - 2) Longitudinal
 - 3) Shear



b) AC motor (3) =

- * It is a small brushless alternator with a rotating multiple permanent magnet.
- * consists of a permanent magnet, coil, rectangular bridge in a moving coil voltmeter.

(5) Stroboscope =

- * It is similar to (3). It can be used to measure rotary speed of an obj, velocity & freq of rotating components & moving parts.

Radiation sensors =

- * The materials used for the construction of these type of (5) are generally → magnetostrictive materials.
- * If an ex force is applied to the material then there occurs a change in the magnetic rate which is ex to the applied force.

This phenomenon → magneto / Villari effect.

- * contain ferromagnetic materials like Ni, Fe, cobalt. Shows this phenomenon.
- * High stability, easy installation.

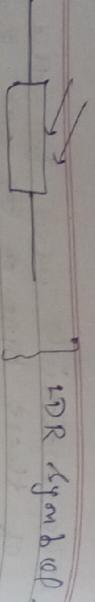
- * It consists of a source of flashing light, whose freq can be varied. This source → Strobotron.
- * 2 types →
 - a) mechanical (3) → are the early (R) device which use interrupted light.
 - b) electronic (3) → modern device to produce very short, repetitive, brilliant flashes of light.

1) LDR = [Light dependent resistors]

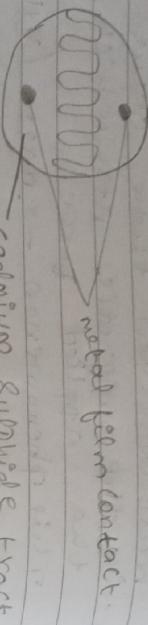
- * Device whose resistance varies with the intensity of light falling on it.
- * Also → photo resistor, photo cell.
- * (3) of LDR is highly sensitive to light.

(6) Magnetostriuctive (7) =

- * It can convert magnetic energy to mechanical energy via versa.

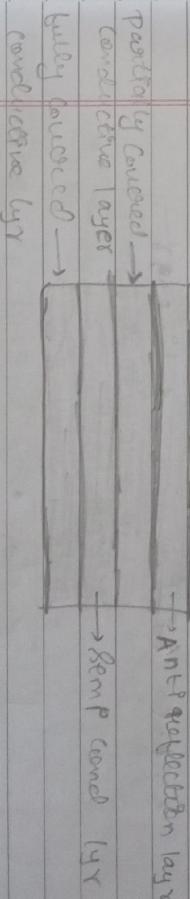


LDR Str →



- * An "interdigital" pattern is used to increase the area of the photodiode that is exposed to light.
- * It is made by material with high σ like Cadmium Sulphide (CdS) ; Lead Sulphide (PbS)
- * These materials have high σ bcz these are very few free when no light fall on them.

This state → high (σ) state of LDR
 So that conductivity of material increases when light falls on it.
 The result is lower the σ of these materials in the presence of light.
 LDR is mainly achieved by semi-cond devices, based on doping LDR —



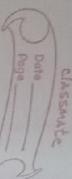
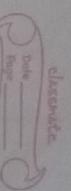
The main layer of PV cell is made of semi cond layer.

These layers convert sun's energy into electrical energy through PV effect.

- (Adv)
- * less cost → ease to use.
 - * when a light LDR is kept in dark, its σ is very high, thus → dark (σ) working

2) Photo voltaic cells =

- * Also → solar cell.
- * Based on the energy harvesting technology.
- * P-V effect & the basic principle is a process of generating electric current in a PV cell when it is exposed to light.
- * These PV cells are formed at a different semicond. → P type & N type.
- * The P region contains more holes than charged holes.
- * N region consists of move due to charged electrons.
- * They are joined together to create P-N junction which has fast response.
- * Sun & Earth can damage easily.

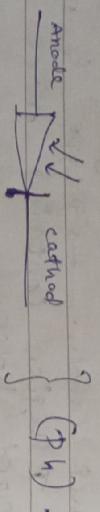


$e^- \rightarrow$ electrons

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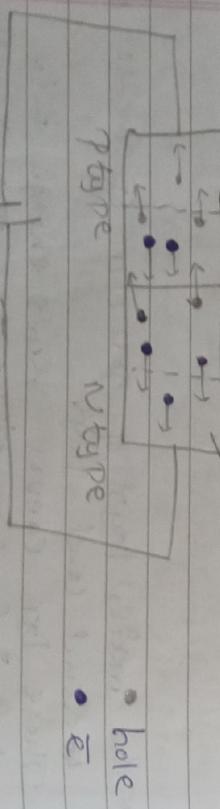
3) Photo diode = (pn)

- * It is a pn junction diode that converts light energy into electrical energy.
- * works in reverse biased condition, i.e. the terminal at btry is connected to n region & -ve terminal to p region of (pn).



- * When light falls on (pn), more e^- generated in n region & more holes will be in p region.
- * Application
 - Adv
 - * need of appin
 - * Photo diode

Incident light absorption region



Btry

4) Photoemissive cells =

- * Also → Phototube
- * Based on photo electric effect.
- * In certain materials, e^- will emit from surface when materials absorbs photon energy → P-electric / P-emissive effect.
- * 2 types →
 - Vacuum type
 - Gas filled type.

(a) Gas filled type
Stable.
low sensitivity

- * Photo multipliers takes gas filled P-emissive tube for better sensitivity.
- * The construction is same for both vacuum type & gas filled p.e. cells.

Amplification = g^n

→ Rec. secondary emission
indicates.

=> Force & Torque (F) =

* Force is any action that stops / changes the motion of a body.

$$F = m \cdot a$$

$m \rightarrow$ mass in kg
 $a \rightarrow$ acceleration
due to gravity.

* Torque is a turning force about an axis which tends to change the linear motion / rotation of a body.

$$T = F \cdot r$$

D-pendulum (D) form

Ans of rotation.

$F \rightarrow$ force

- * force (F) = used to (T) a physical force into an electrical signal.
eg \rightarrow strain gauge, LVDT.

- * ~~used~~ in robotics.

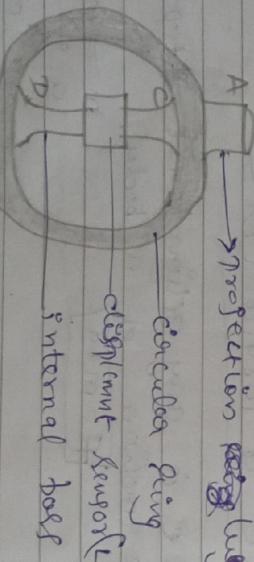
- * Torque (T) = convert torsion corresponding to a torque of the shaft to an electrical quantity.
Eg \rightarrow RMT, magnetic torque (T)

- 3) proving ring / elastic force (F) =

- * most significant device for measurement of force.

- * force to be measured is applied to the elastic member which is available in the form of rings, cylinders etc.

- * mainly used for measurement of large force.



P. ring
displmt sensor (LVDT)
internal boss

2) Pneumatic & Hydraulic load cell =

- * Load cell \rightarrow force (F) which converts a force into an electrical signal.
* force may be tension, compression, pressure to you.

- * common types of load cells =

- * consists of an elastic diaphragm which is attached to a platform surface where the weight will be measured.

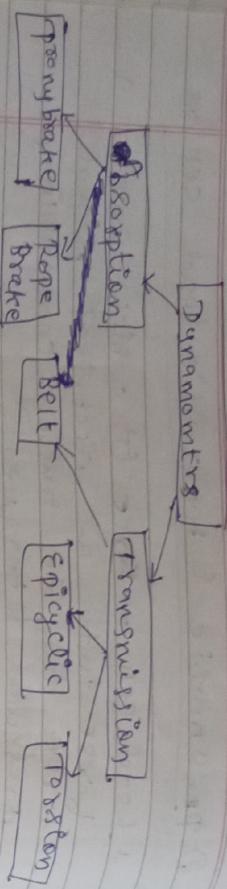
b) Hydraulic load cell =

- * This sensor will work by using fluid, whether oil or liquid.

- * Similar pneumatic load cell but instead of air, they use pressurized liquid.

3) dynamometer =

- * device used to measure frictional (F_f).
By knowing the frictional (F_f), we can determine the torque transmitted & hence power of an engine.
can be used either to measure force, torque / power.



- * Absorption (dy) measure of absorb the power output of the engine to which they are coupled.
- * transmission (dy), energy is not for friction it is used for doing work.

a) Prony Brake (dy) =

- * It is one of the simplest form of absorption (dy)
- * It works on the principle of converting power into heat by dry friction.

b) Belt Transmission (dy) =

- * Type of transmission (dy).
- * consists of driving pulley, rigidly fixed to the shaft of the prime mover.

\Rightarrow whyroscope =

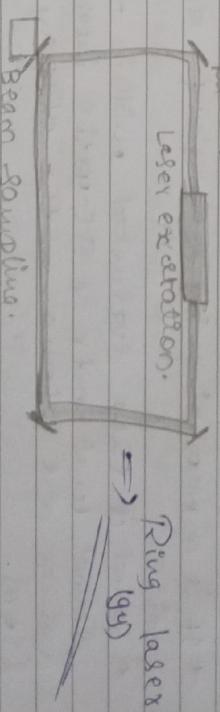
- * A device used for measuring main bearing orientation & angular velocity
- * consist of a spinning wheel in 2/3 gimbal.

- * outermost gimbal \rightarrow frame
- * Axis of rotation of the gyro wheel tends to remain in a fixed (gyro) in space if no force is applied to it.
- \hookrightarrow rigidity.
- \Rightarrow gyroscopes, in automobile.

a)

Ring Laser gyroscope =

- * can measure any rotation about its sensitive axis.
- (i.e.) orientation in inertial space will be known at all times.



Beam Sampling.

\Rightarrow Sound (S.T) =

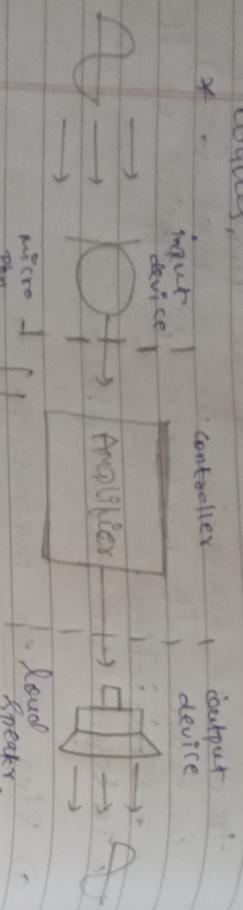
- * Device that can convert sound signals into electrical signals i.e. vice versa.
- * In the former case, they are \rightarrow Input S.T
- * i.e. a microphone is an e.g.
- * In the latter case, they are \rightarrow output S.T
- * i.e. a speaker is an e.g.
- * The sound that we hear & basically made up from mechanical vibrations produced by an audio S.T.

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(m) → Resistivity
→ Distortion
→ Directivity
→ Output impedance.

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* Audio is used to generate the acoustic waves.



→ Microphones = (m)

- * Instrument that convert sound to e. signal
- * Basically it's a (D).
- * (m) takes sound wave in pressure of air as input & gives electrical signals as an output.
- * most common (m) are
 - a) carbon (m)
 - b) moving coil (m)
 - c) ribbon (m)
 - d) capacitive (m).
- A commonly (m) are connected to an amplifier before it gets measured.

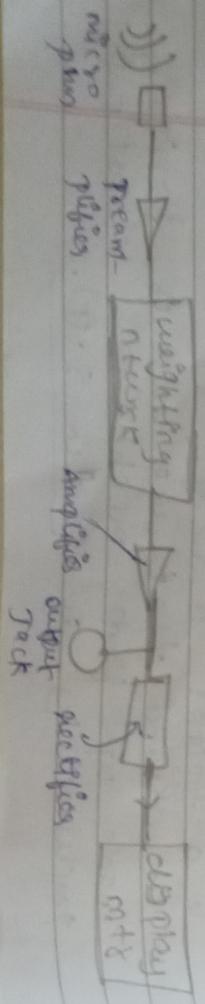
bcz the e. signals generated by a (m) is very small if measured in millivolts. (m)'s sensitivity is a measure of the voltage developed per unit sound pressure.

→ Types of (m) →

- * Sound level meters = (SLM)
- * It is a measuring instrument used to access noise.
- * Sound if then evaluated within the sound level mtr of a acoustic measurement values are shown on the display of (SLM).

a) Condenser | capacitive (m) =

- * Some SLM devices can be permanently installed for continue monitoring of sound level at a work.
- * It is commonly a hand-held instrument with a microphone.
- * Best type of microphone for SLM is the condenser microphone which combines precision with stability & durability.



microphone
Amplifier
output specifies

b) Ribbon (m) = (cm)

A thin metal ribbon is

used as a sensing element in

telecom. As it is placed in a mag. field

* Basic principle → magnetic induction.
As when a magnet vibrates, it will produce
a voltage which is called the sound

frequency.

* Basically it's a diaphragm speaker engine.