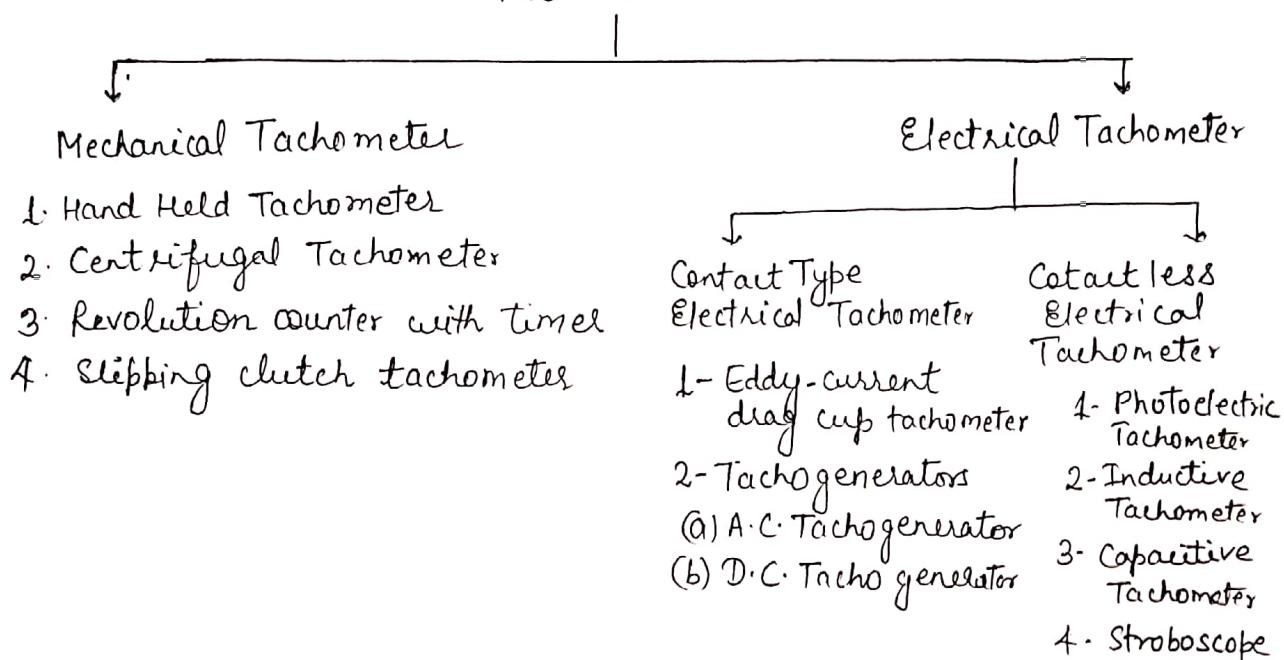


[Time Related Measurements and Displacement Measurement]

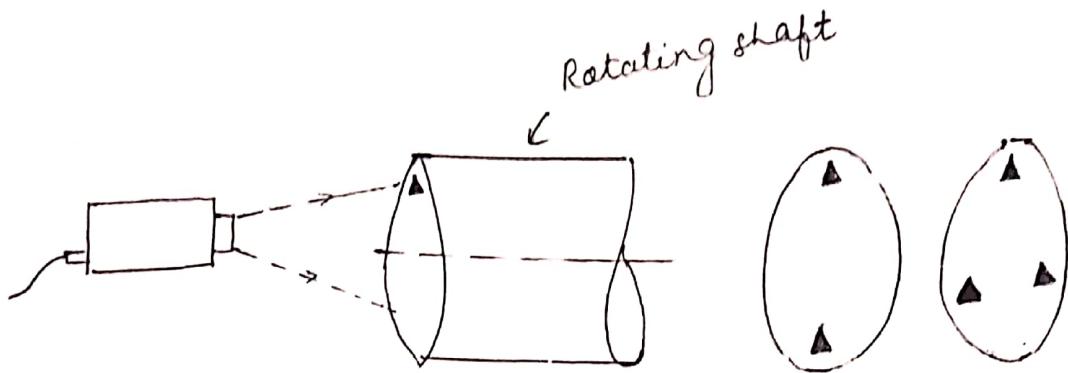
Time related measurements refer to speed measurement and frequency measurement. Study of speed of rotation is often referred as tachometry. RPM or angular speed is measured with a device known as tachometer.

Tachometers



Stroboscope :

An stroboscope is an angular speed measuring instrument which can be used to measure upto 25,000 rpm. RPMs can be measured by using electronic stroboscope lamps. The stroboscope lamp flashes light at some known frequency. The frequency of the light can be adjusted over a range. The light is flashed on the shaft or some other rotating member like blades of a fan, gear teeth of gears or spokes of a wheel. While flashing the light on the target, the frequency of light is adjusted by using a suitable knob until the target seems to be stationary. In this condition RPM of the shaft or rotating member equals the frequency of light being flashed on it.



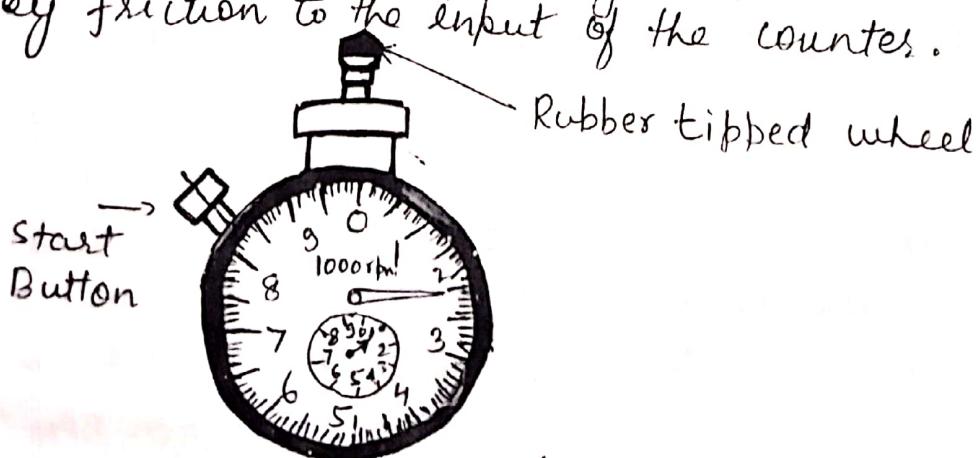
(Electronic flash light stroboscope)

If frequency of rotation of shaft is less than light's flashing frequency, multiple marks can be observed. If frequency of light is double than shaft frequency, two marks will be seen 180° apart. If light frequency is three times of the shaft frequency, three marks will be observed 120° apart and so on as shown in the figure.

Hand Held Tachometer :

It is the simplest and least expensive type of tachometer. It can be used to measure, shaft rotation in the range of 20,000 rpm to 30,000 rpm.

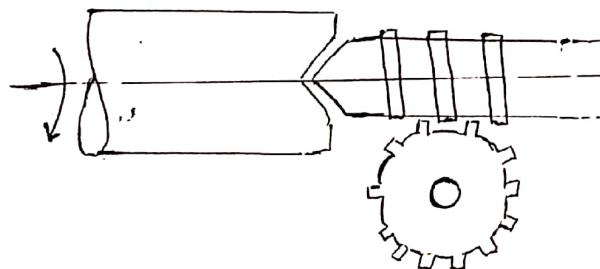
It consists of an integrated stop watch and a counter having an automatic disconnect system. They are supplied with rubber tipped wheel, which when brought in contact with the rotating shaft, transmit its motion by friction to the input of the counter.



(Hand Held Tachometer)

Revolution counter with timer :

The system is used to measure rotations in the range of 2000 rpm to 3000 rpm. The revolution counter has a worm and worm-wheel arrangement. The rpm's available at the shaft are reduced by a gear train. The worm drives the spur gear which in turn actuates a pointer over a calibrated scale. The pointer indicates the no. of rotations of the shaft in a certain time period which is measured by a separate timer or stop watch.



Tachogenerators :

Tachogenerators also known as tachometers, are the electromechanical devices which transform mechanical energy into electrical energy, hence have been successfully used to measure shaft speed. In tachogenerator, the magnetic flux remains constant and e.m.f induced is proportional to the angular speed of the shaft. Tachogenerators are of two types.

- ① A.C. Tachogenerators
- ② D.C. Tachogenerators

D.C. Tachogenerators :

It is the most commonly used tachogenerator. It consists of an iron core rotor and permanent magnet as shown in figure. The magnetic field is provided by the permanent magnet and so no external supply voltage is required for this purpose. The input to the tachometer is the speed of the shaft and the output is voltage which is proportional to the speed of the shaft. The output winding is located on the rotor. The output voltage of tachogenerator is given by the relation,

$$V_{\text{output}} = KN$$

where N is rpm of the shaft and K is a constant.

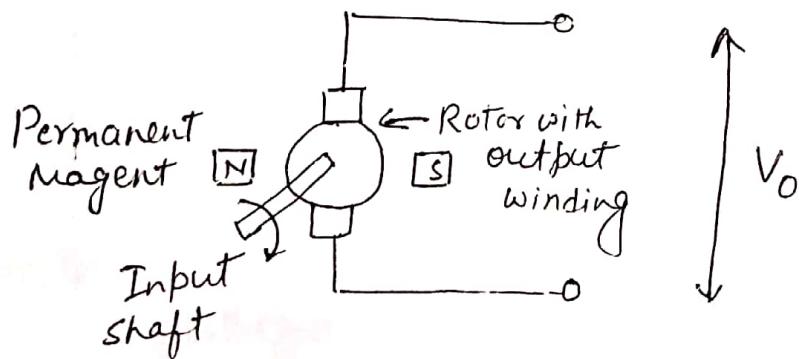
$$\text{and } K = \frac{n_p n_c \phi}{60 n_{pb}}$$

where $n_p \rightarrow$ no. of poles

$n_c \rightarrow$ no. of conductors in armature

$\phi \rightarrow$ flux per pole

and n_{pb} is the no. of parallel paths between +ve and -ve brushes.



(D.C. Tachogenerator)

For measuring rpm of the shaft, the shaft is coupled with rotor

AC Tachogenerators :

A.C. Tachogenerators are similar to two phase induction motors. In this, two stator windings are placed in quadrature with each other and rotor is short circuited as shown in figure. The rotor of AC tachogenerator is tin aluminium cup. The two stator windings are known as primary winding and secondary winding. The magnitude of output voltage will be proportional to the rotor speed.

