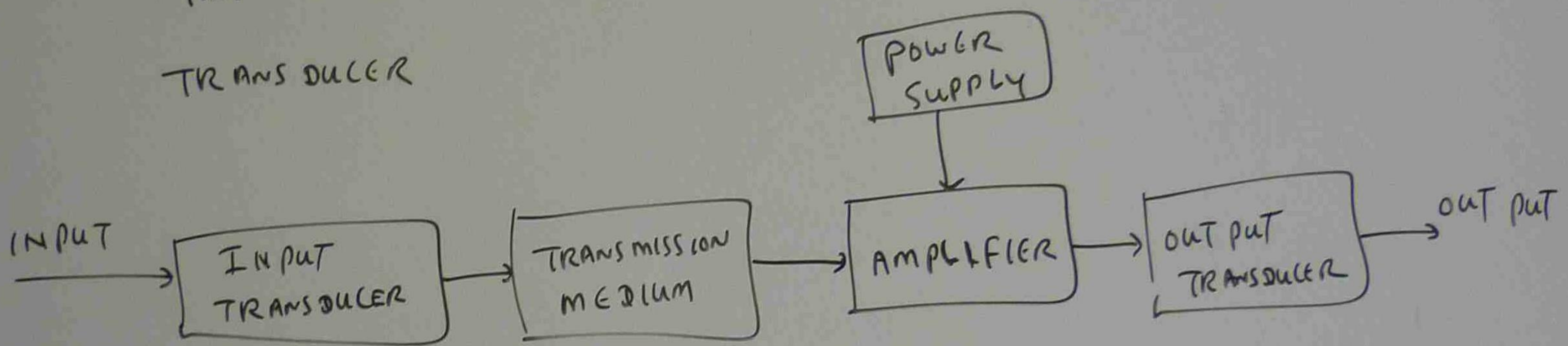
ELECTRONIC SIGNALS AND SYSTEM IN PROCESS CONTROL

SYSTEM

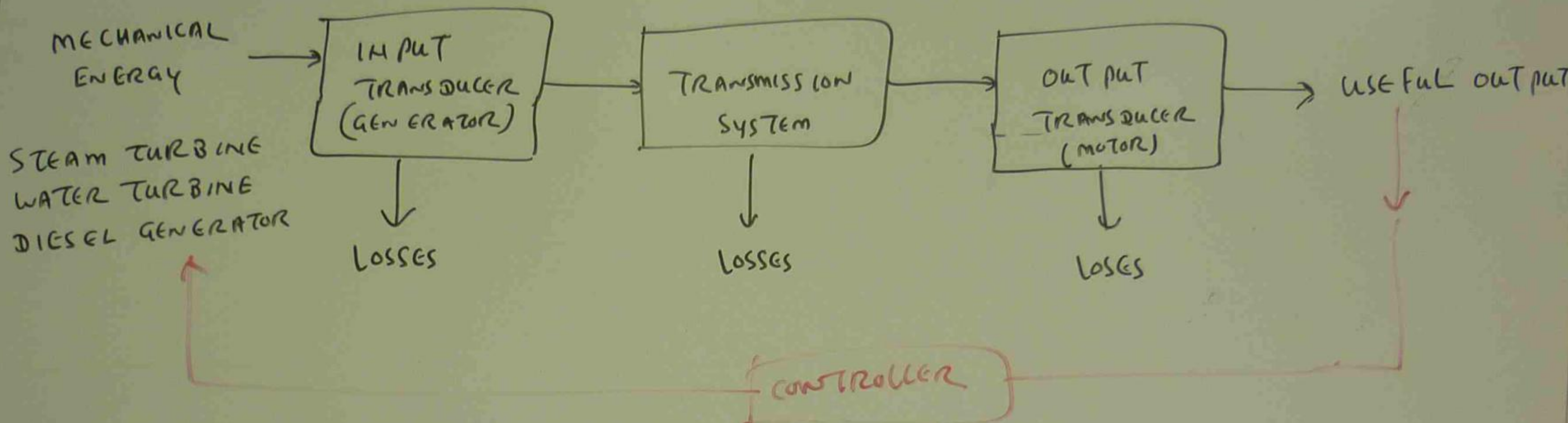
ELECTRICAL, MECHANICAL, THERMAL, HYDRAULIC, PRESSURE

THOSE QUANTITIES ARE CONVERTED TO ELECTRONIC SIGNALS BY TRANSDUCER



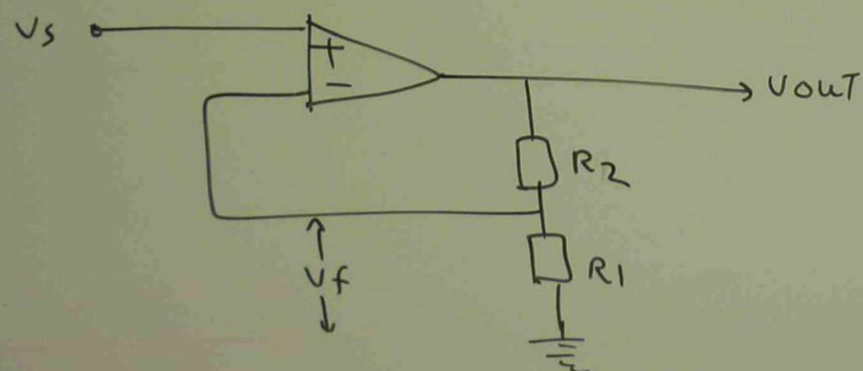
* THE PURPOSE OF INPUT TRANSDUCER IS TO CONVERT THE INFORMATION FROM THE SOURCE IN TO INPUT SIGNAL.

POWER DISTRIBUTION SYSTEM



T PUT

NEGATIVE FEEDBACK AMPLIFIER

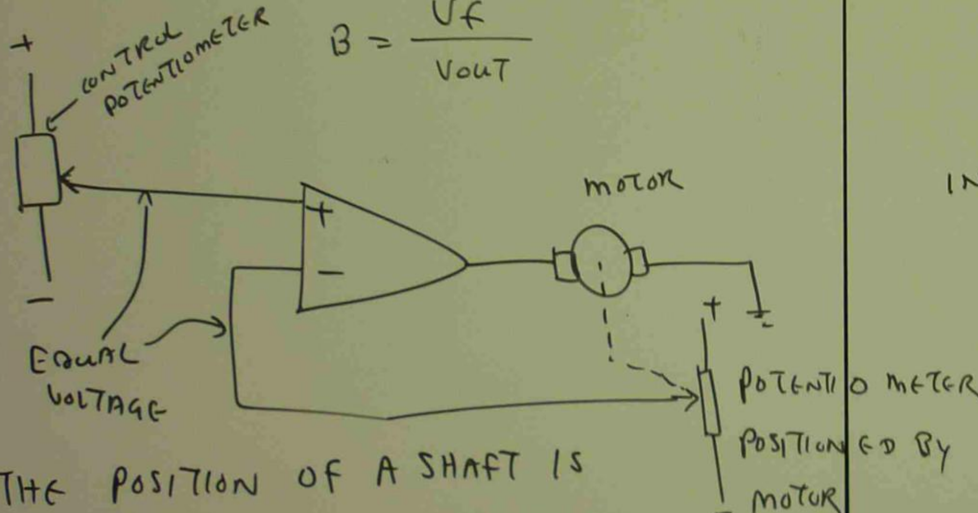


$$V_f = \frac{R_1}{R_1 + R_2} V_{out}$$

THE OUTPUT VOLTAGE IS SAMPLED BY THE RESISTIVE VOLTAGE DIVIDER TO PRODUCE A FEED BACK VOLTAGE V_f. THIS VOLTAGE IS COMPARED (SUBSTRACTED FROM) THE ORIGINAL INPUT SIGNAL AND THE DIFFERENCE IS AMPLIFIED.

$$\text{AMPLIFIER GAIN} = A = \frac{V_{OUT}}{V_{IN}}$$

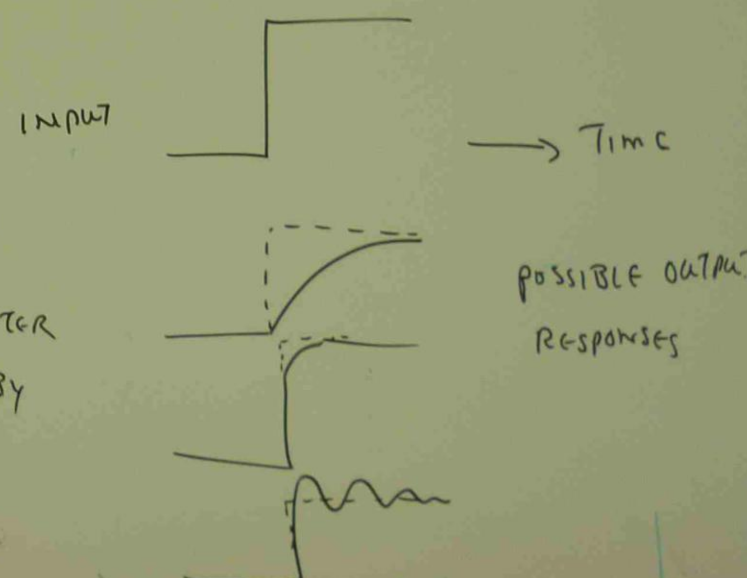
$$B = \frac{V_f}{V_{OUT}}$$



THE POSITION OF A SHAFT IS CONTROLLED BY A POTENTIOMETER. THE AMPLIFIER ADJUSTS THE POSITION OF THE SHAFT UNTIL THE CONTROL POTENTIOMETER AND THE POSITION SENSING POTENTIOMETER ARE EQUAL.

ALL FEED BACK SYSTEMS ARE AFFECTED BY INERTIA OF SOME KIND.

FEED BACK AMPLIFIERS ALWAYS HAVE CAPACITANCE WHICH PROVIDES INERTIA AND AFFECT THE RESPONSE TO A CHANGE IN INPUT



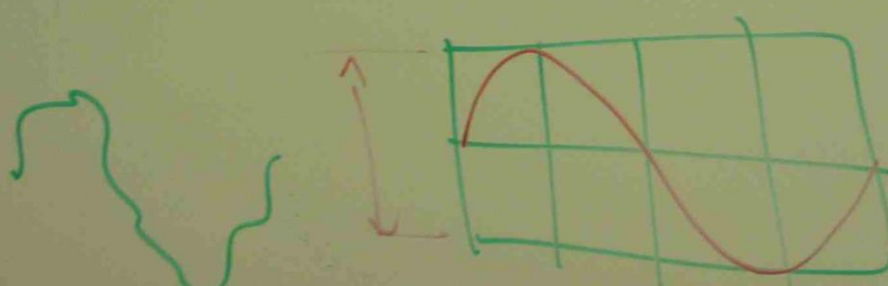
SIGNALS, SPECTRA AND NON LINEARITY

TIME AND FREQUENCY DOMAINS

THE TRADITIONAL METHOD OF OBSERVING ELECTRICAL SIGNAL IS TO VIEW THEM IN TIME DOMAIN USING OSCILLOSCOPE

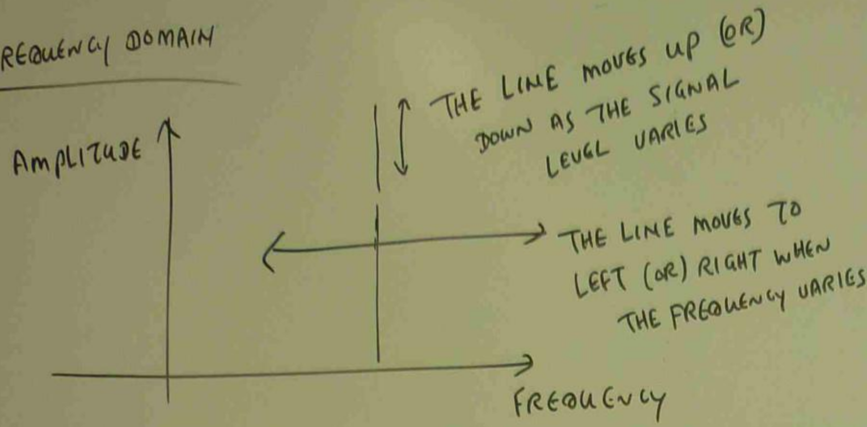
THE INFORMATION DISPLAYED IS AMPLITUDE (VOLTAGE) VERSUS TIME. WHICH IS ADEQUATE FOR MOST LOW FREQUENCY AUDIO AND DIGITAL WAVE FORM MEASUREMENTS INVOLVING TIMING AND PHASE.

OSCILLOSCOPE CAN NOT VIEW MHZ SIGNAL



$$f = \frac{1}{\text{DIVISIONS} \times \text{TIME}/\text{DIV}}$$

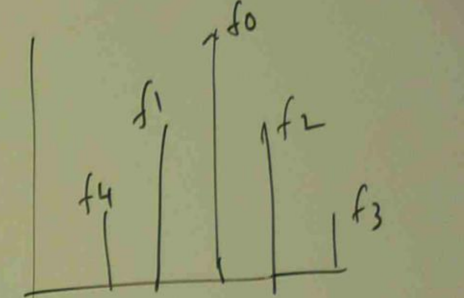
FREQUENCY DOMAIN



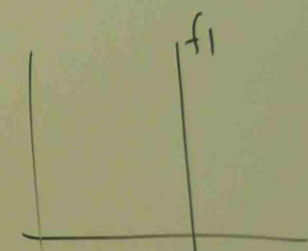
THE SPECTRUM ANALYZER DISPLAYS AMPLITUDE VERSUS FREQUENCY ON SCREEN.

A SIGNAL HAVING ONLY ONE FREQUENCY COMPONENT APPEARS AS A SIGNAL VERTICAL LINE.

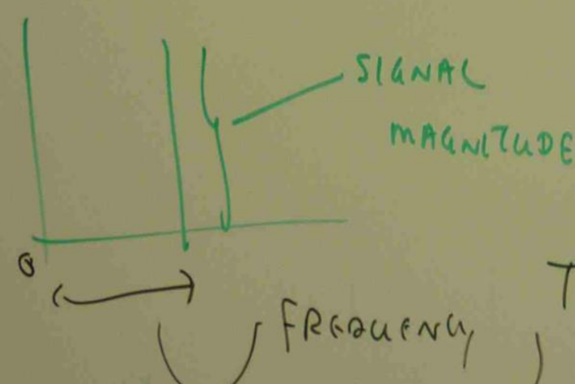
THE POSITION OF THIS VERTICAL LINE ALONG HORIZONTAL AXIS TELLS US FREQUENCY.



SEVERAL FREQUENCIES



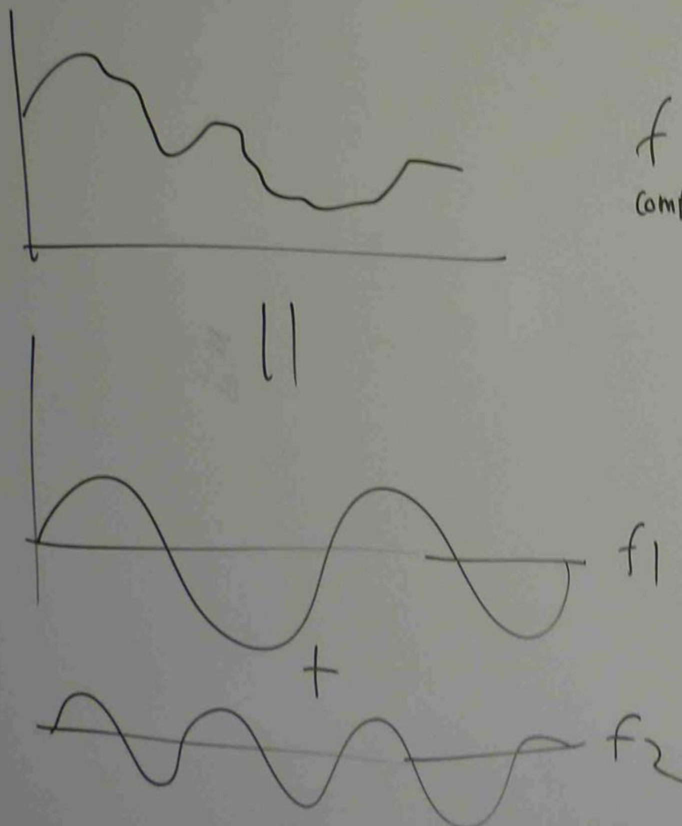
SINGLE FREQUENCY



$TIME = \frac{1}{FREQUENCY}$

FUNDAMENTAL OF FOURIER ANALYSIS

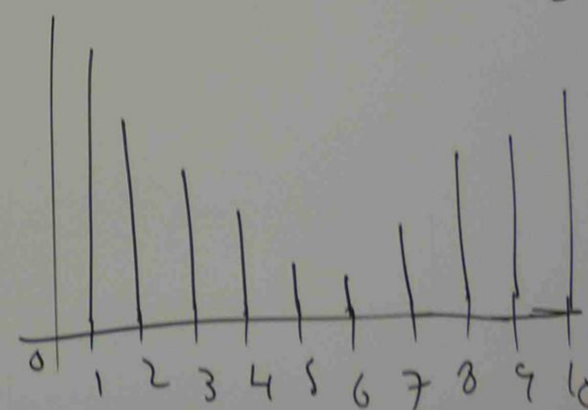
A COMPLEX PERIODIC WAVEFORM MAY BE ANALYZED AS A NUMBER OF HARMONICALLY RELATED SINUSOIDAL WAVES.



$$f_{complex} = f_1 + \underbrace{f_2 + f_3 + \cdots}_{\text{HARMONIC}}$$

FUNDAMENTAL

$$X_C = \frac{1}{2\pi f C}$$



pb — A WAVE FORM HAS A PERIOD $T = 40\,ms$. CALCULATE THE FREQUENCY OF THE FUNDAMENTAL, THE SECOND, THIRD AND FOURTH HARMONICS.

FUNDAMENTAL FREQUENCY $= \dfrac{1}{T}$

$= \dfrac{1}{40 \times 10^{-3}}$

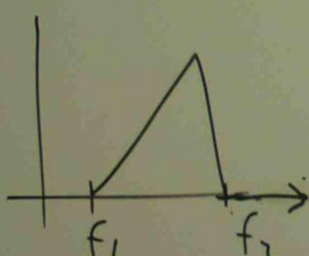
$= 25\ Hz$

SECOND HARMONIC $= 2f = 2 \times 25 = 50\,Hz$

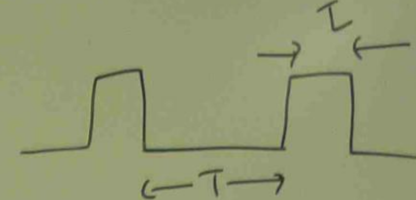
THIRD HARMONIC $= 3f = 3 \times 25 = 75\ Hz$

FOURTH HARMONIC $= 4f = 4 \times 25 = 100\,Hz$

SYMBOLIC REPRESENTATION OF BASE BAND

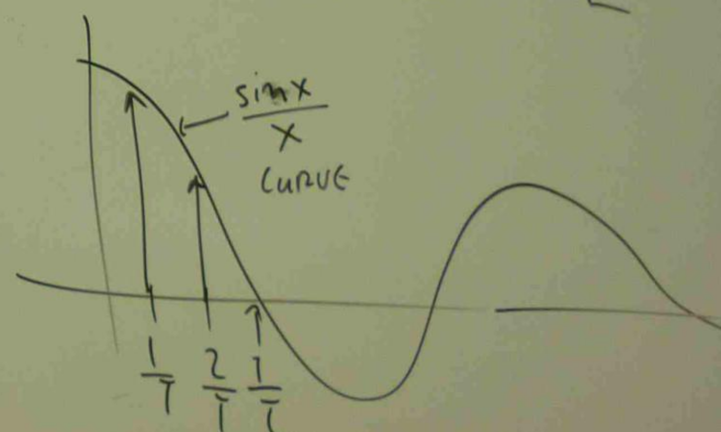


PULSE TRAIN

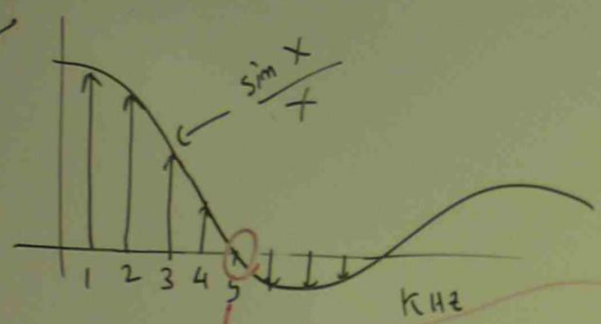


T = PERIOD, τ = PULSE WIDTH

$\dfrac{\sin x}{x}$ CURVE CORRESPONDS TO FREQUENCY $\dfrac{1}{\tau}$



PD



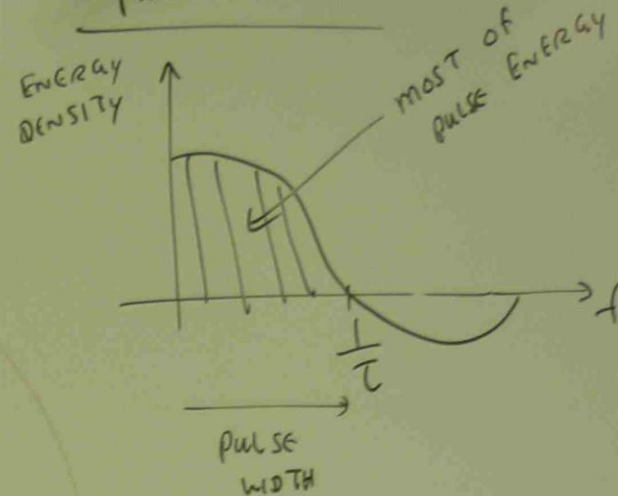
$T = 1\ ms$, $\tau = 0.2\ ms$

LOCATE 5 KHZ AT THE FIRST ZERO OF THE CURVE.

$$\frac{1}{T} = f_1 = \frac{1}{1 \times 10^{-3}} = 10^{3}\ Hz = 1\ KHZ \longrightarrow (1)$$

$$f = \frac{1}{\tau} = \frac{1}{0.2 \times 10^{-3}} = 5\ KHZ \longrightarrow (5)$$

PULSE ENERGY



HARMONIC DISTORTION

$$V_{in} = A \sin \omega t \quad \text{(FUNDAMENTAL)}$$

$$V_{in} = A_1 \sin \omega_1 t + \underbrace{A_2 \sin \omega_2 t}_{\text{HARMONIC}}$$

EXAMPLE

A 1 KHZ SINE WAVE AND 10 KHZ SINE WAVE ARE ADDED TOGETHER AND APPLIED TO A NON LINEAR DEVICE.

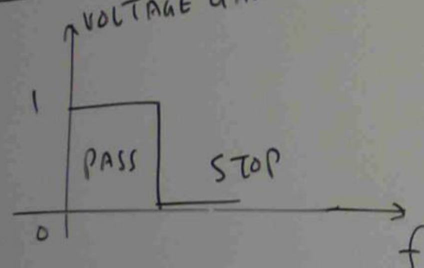
THE OUT PUT WILL INCLUDE.

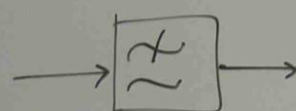
- 1 KHZ, 10 KHZ (ORIGINAL FREQUENCIES)
- 2 KHZ, 3 KHZ, 4 KHZ (HARMONICS OF 1 KHZ)
- 20 KHZ, 30 KHZ, 40 KHZ (HARMONICS OF 10 KHZ)
- 9 KHZ (f_3), 11 KHZ (f_4) ($f_1 \pm f_2$ — 2nd ORDER INTER MODULATION)
- 8 KHZ, 12 KHZ, 19 KHZ, 21 KHZ ($f_1 \pm f_3$, $f_2 \pm f_4$ - 3rd ORDER INTER MODULATION)

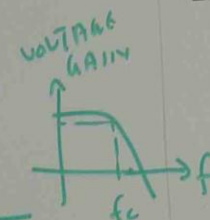
FILTERS

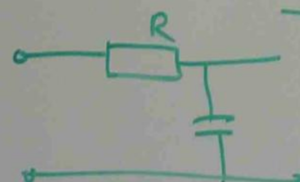
- LOW PASS
- HIGH PASS
- BAND PASS
- BAND STOP.

LOW PASS

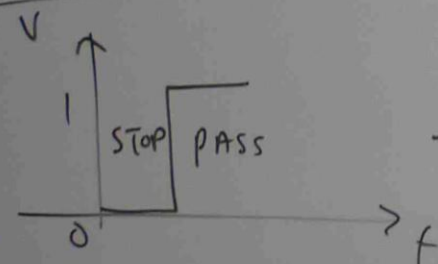


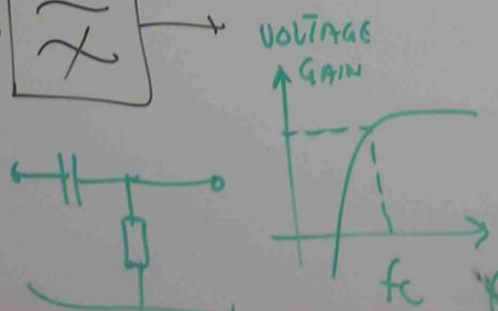




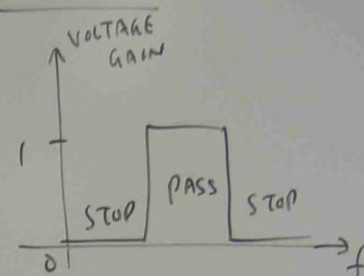


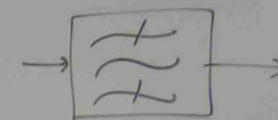
HIGH PASS



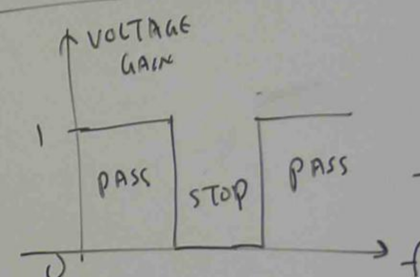


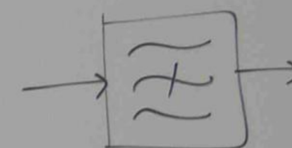
BAND PASS



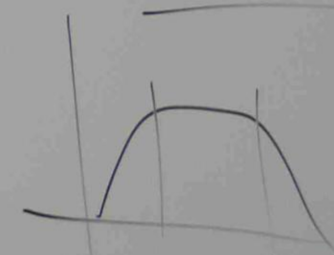


BAND STOP

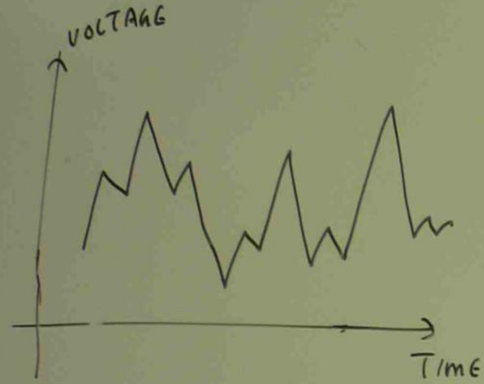


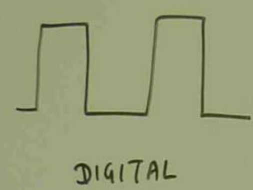


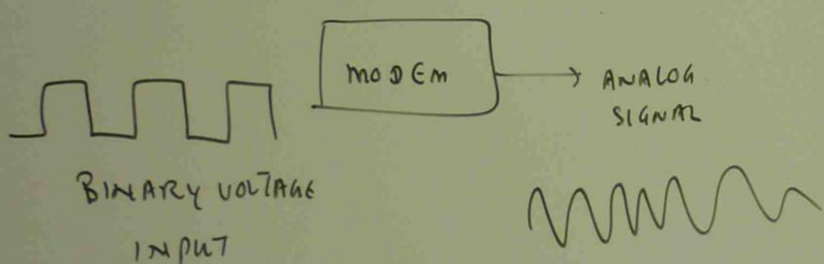
BAND PASS



ANALOG AND DIGITAL SIGNALS

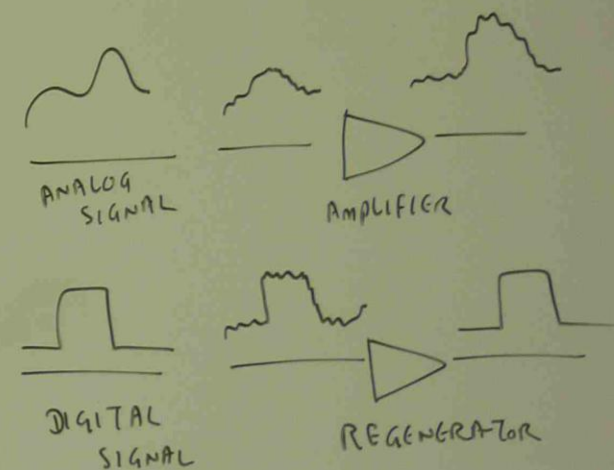






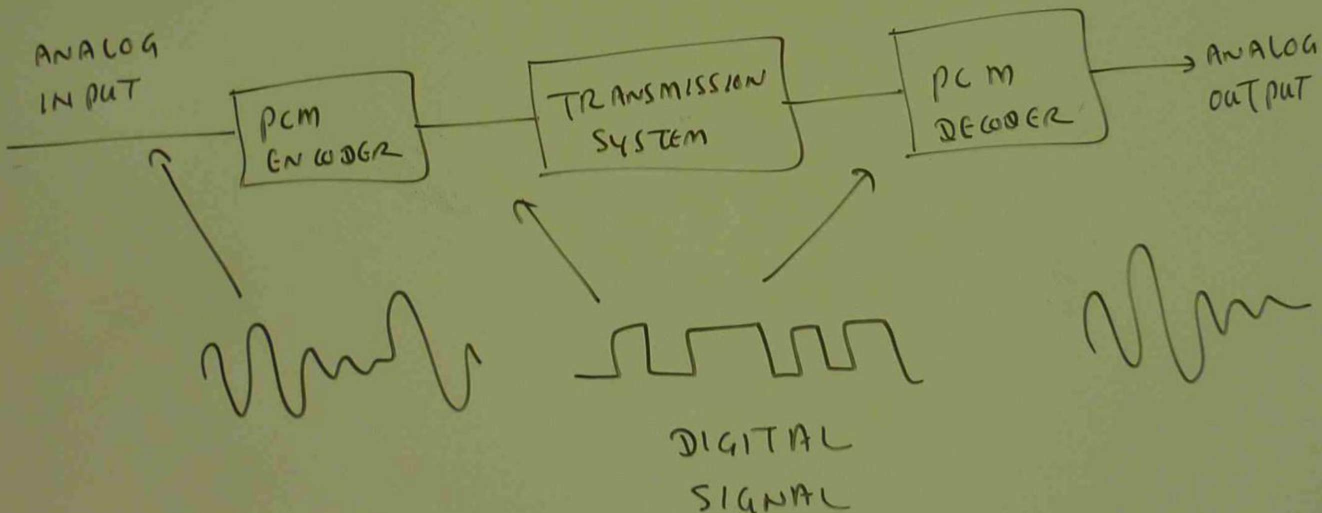
DEGRATION OF SIGNALS IN TRANSMISSION

WHETHER ANALOG (OR) DIGITAL TRANSMISSION IS USED, THE RECEIVED SIGNAL WILL BE DIFFERENT FROM THE ORIGINAL BECAUSE OF NOISE ADDED AT EVERY STAGE



PULSE CODE MODULATION (PCM)

PC IS A MEAN OF COMMUNICATION IN WHICH AN ANALOG SIGNAL IS ENCODED IN TO A DIGITAL SIGNAL. THEN TRANSMITTED OVER A TRANSMISSION MEDIUM IN A DIGITAL FORMAT AND FINALLY DECODED BACK IN TO ITS ORIGINAL ANALOG FORM

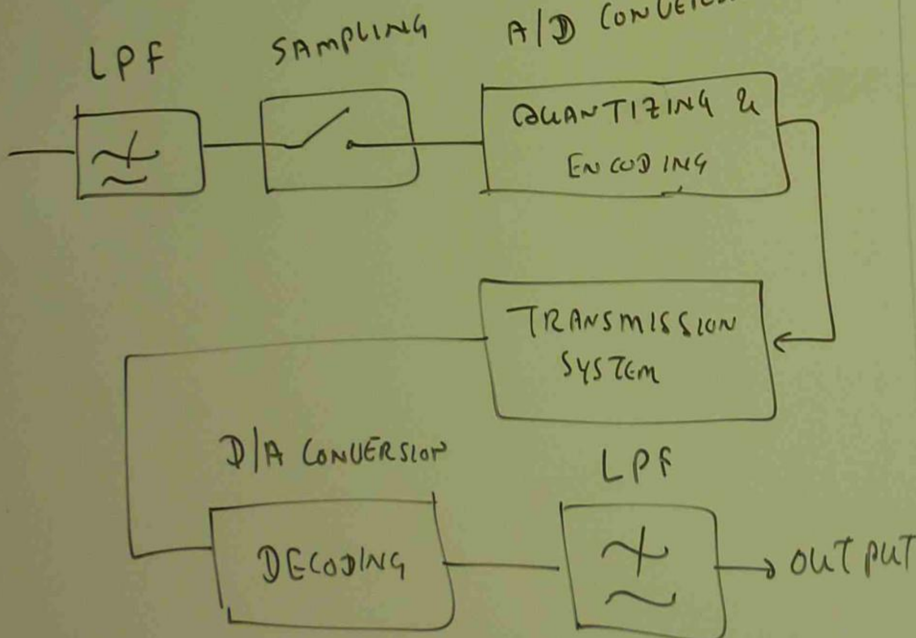


PCM HAS HIGH IMMUNITY TO NOISE AND INTERFERENCE

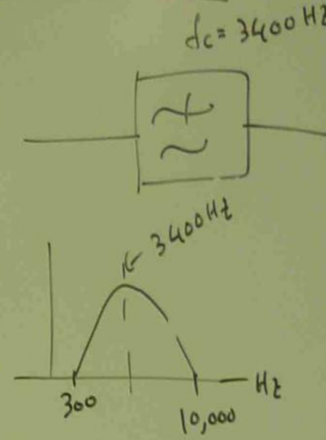
THE PCM ENCODING PROCESS

THE BASIC PCM ENCODING PROCESS INVOLVES THE FOLLOWING STEPS

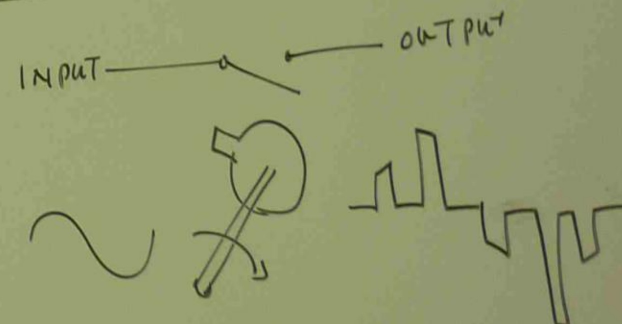
- LOW PASS FILTERING
- SAMPLING
- ANALOG TO DIGITAL CONVERSION (QUANTISATION & ENCODING)



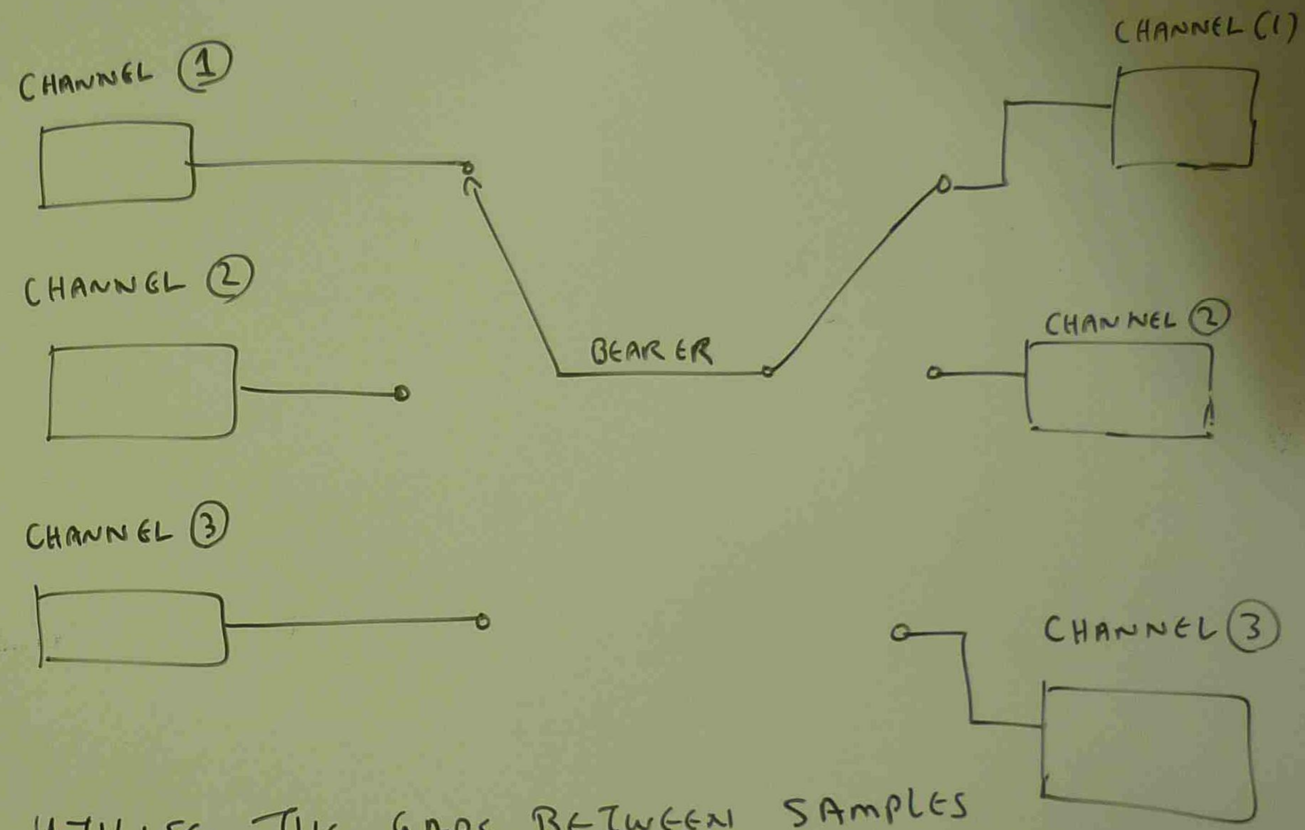
LOW PASS FILTERING



SAMPLING



TIME DIVISION MULTIPLEXING

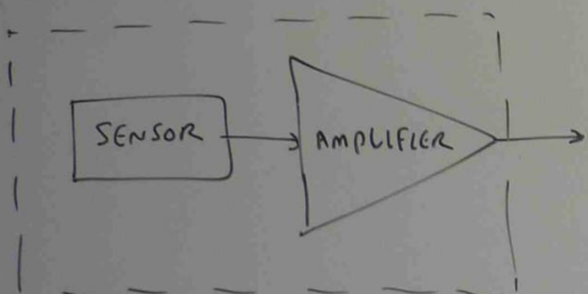


UTILISE THE GAPS BETWEEN SAMPLES WITH SAMPLES FROM OTHER MESSAGE SOURCES.

INDUSTRIAL TRANSDUCERS

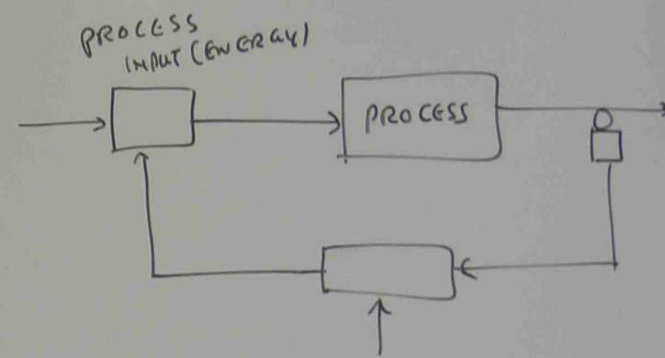
- A TRANSDUCER CONSISTS OF THE SENSOR AND ITS ASSOCIATED CIRCUITRY TO PRODUCE AN OUTPUT SIGNAL.

- A SENSOR IS A DEVICE THAT DETECTS A CHANGE IN PHYSICAL STIMULUS AND CONVERT THIS CHANGE TO A SIGNAL THAT CAN BE MEASURED.

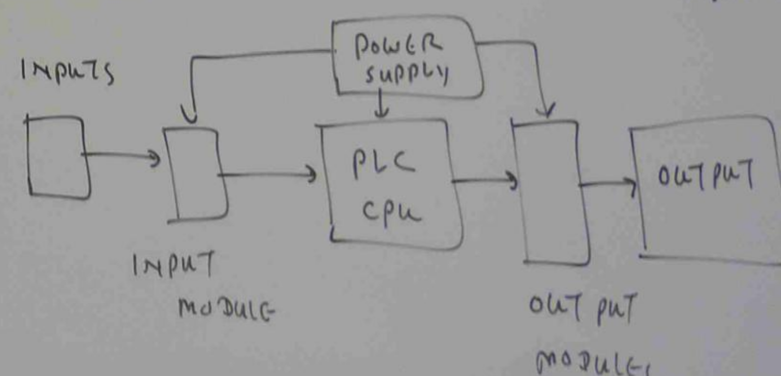


TRANSDUCER

TRANSDUCERS FORM AN IMPORTANT COMPONENT IN ANY CLOSED LOOP CONTROL SYSTEM (OR) PROGRAMMABLE CONTROLLER (PLC) SYSTEM USED IN INDUSTRIAL CONTROL.



CLOSED LOOP CONTROL SYSTEM



TEMPERATURE MEASUREMENT

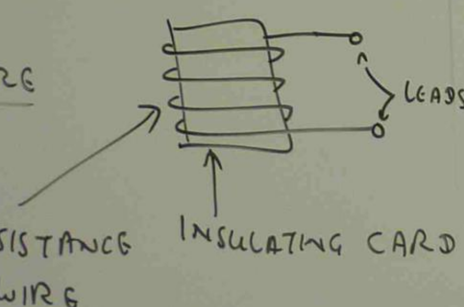
WHEN TEMPERATURE MEASUREMENTS ARE MADE, ONE OF TWO VARIABLES CAN BE DETERMINED.

- TEMPERATURE (ANALOGOUS TO VOLTAGE)
- HEAT (ANALOGOUS TO CURRENT)

TEMPERATURE MEASUREMENT IN INDUSTRY CAN RANGE FROM $-267^{\circ}C$ TO $+7500^{\circ}C$

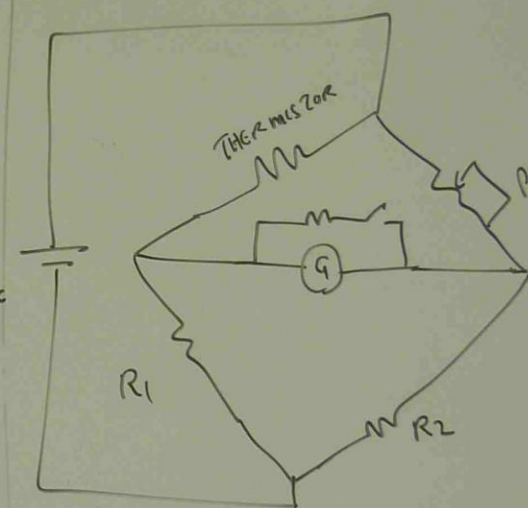
THERMOCOUPLES - MEASURE BETWEEN $500^{\circ}C$ AND $1500^{\circ}C$
CONSISTS OF HOT & COLD JUNCTION

RESISTANCE TEMPERATURE DETECTORS (RTD)

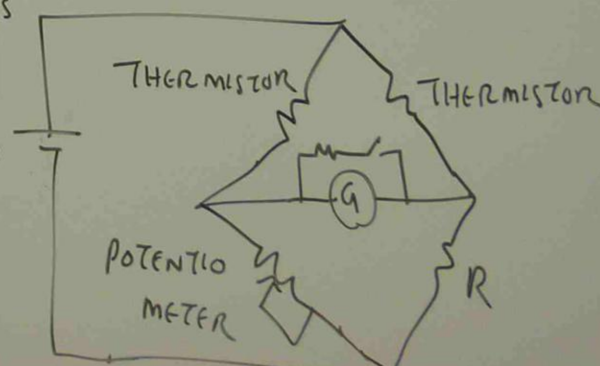


THERMISTOR

POSITIVE TEMPERATURE COEFFICIENT
NEGATIVE TEMPERATURE COEFFICIENT



THERMISTOR BRIDGE



DIFFERENTIAL THERMISTOR BRIDGE

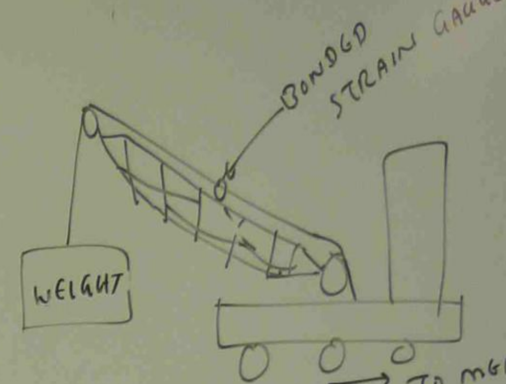
FORCE MEASUREMENT

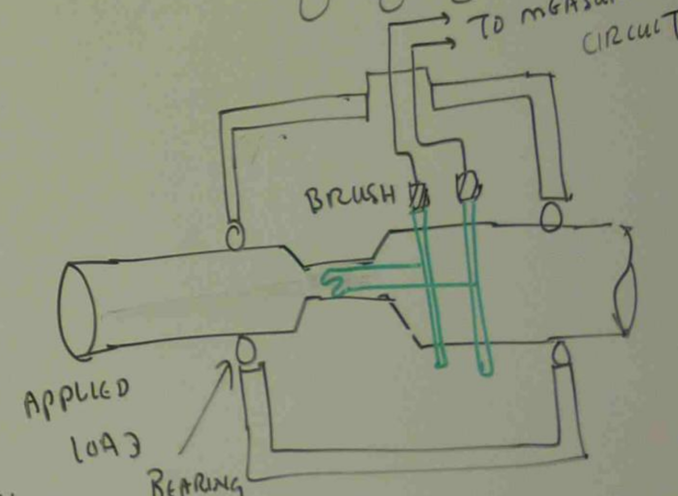
THE STRAIN GAUGE

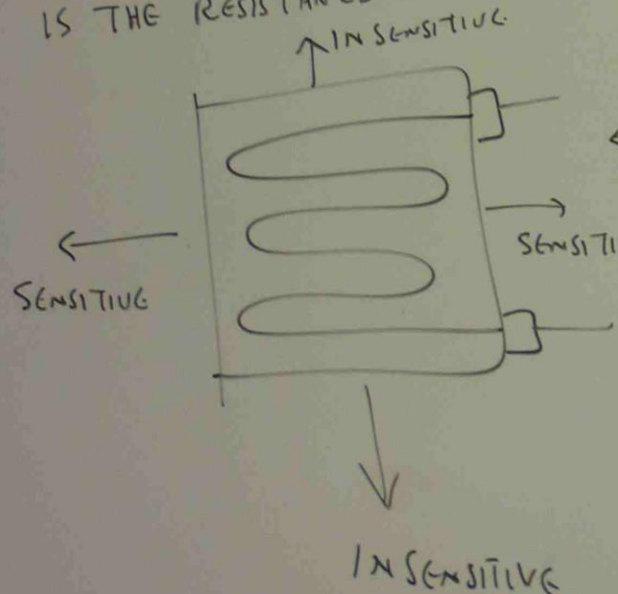
THE STRAIN, LOAD, TORQUE, ACCELERATION AND VIBRATION ON AN OBJECT CAN BE DETERMINED BY MEASURING THE DISPLACEMENT OF PREDETERMINED POINTS.

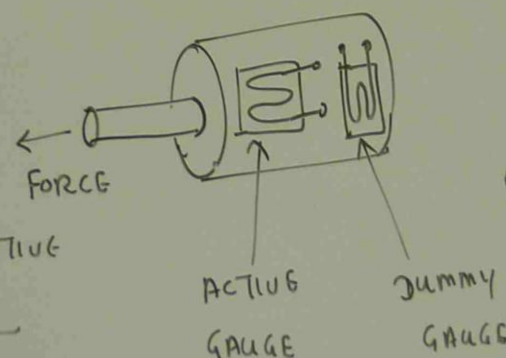
THE AMOUNT OF DISPLACEMENT IS VERY SMALL. (μm).

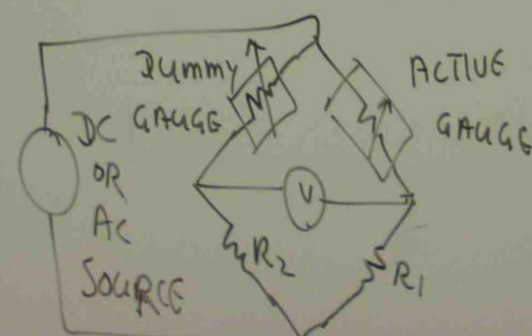
A SENSOR COMMONLY USED TO DETERMINE THE DISPLACEMENT IS THE RESISTANCE STRAIN GAUGE.









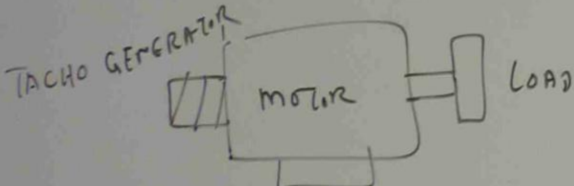


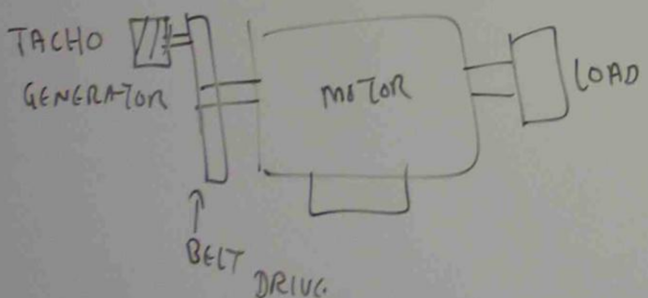
SPEED MEASUREMENT

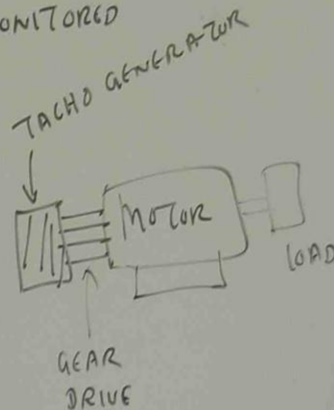
TACHO GENERATOR

TACHO GENERATORS ARE USUALLY SMALL PERMANENT MAGNET DC GENERATOR.

THEY ARE COUPLED TO THE MOTOR TO BE MONITORED THE SPEED.

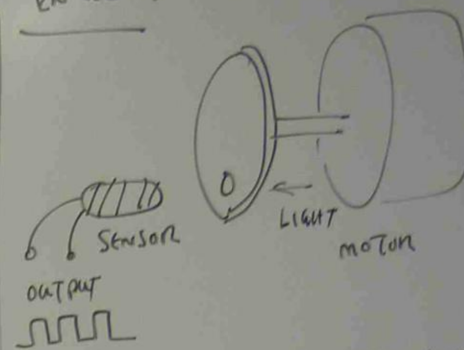






GEAR COUPLED

ENCODER

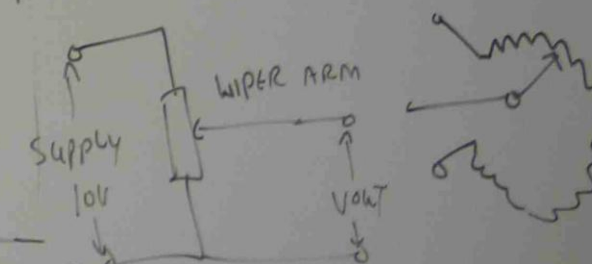


ANALOG TO DIGITAL CONVERSION

(1)

POSITION MEASUREMENT

POSITION TRANSDUCERS
- PRECISION POTENTIOMETER
- SYNCHROS
- ENCODERS



SYNCHRO