

Chapter: 01 (Introduction to Instrumental System)

1.1 Company

(i) Instrumentation: Instrumentation ^{प्र० ३२)} Technology ^(क)
of physical & chemical properties
of material in measure and control ^{प्र० १}
Eg: Ecr. & washing machine, fan.

(ii) Instrument: A device which measures physical quantity.

1 iii) Process Instrumentation: (P.I) Instrument used to measure and control processes. Process control is a part of process instrumentation.

1.1. Components of Instrumentation & their function.

- (i) Quantity to be measured: वर्तमान Physical quantity गिरा !
- (ii) primary Sensing element: अवृत्ति क्षेत्रीय Contact गिरा !
physical quantity डॉट गिरा !

Note : Transducer is a device which converts Non electrical quantity into electrical quantity by change in state.

Eq : LDR microphone.

(iii) Variable conversion element: વાર્ષાળી સિસ્ટમ ની એ
પ્રાથમિકી બિગતિયાં ફોર્મ રીટ્ચ કરે
this Digital or Analog: Eg. ADC (Analog to
Digital converter).

- iv) Variable manipulation element: विभिन्न सिग्नल
लाई बदलने वाला amplifier or filter
Eg: Electronic amplifier.
- v) Data transmission element: सिग्नल को प्रसिद्ध
संकेत या जांची transmit करने वाला eg: telemetry
radio signal.
- vi) Data presentation element: सिग्नल को display
करने वाला Eg: voltmeter, Ammeter, Led display etc.

(1.3.) Signal Conditioning & transmission

→ अवश्यक transducer का Output अनुमति की
Signal की Amplification, filter, ADC conversion
etc.
Eg: Amplifier, ADC

1.4 Output device: display device Eg:
monitor, printer, speaker, projector.

1.5 Signals: Something that like possess information.

Types of Signals

- (i) Continuous & Discrete time Signals.
- (ii) Deterministic & random Signals.
- (iii) Even & odd .. "
- (iv) Periodic & non-Periodic Signals.

Chapter: 2 Signal measurements

Q.1. Unit :- वस्तु की Object लाई जानेलाई पास के ~~परिमाण~~
प्रजलाई Unit कहते हैं।

Standards of measurement of types

- International standards : विदेशी maintain वाले International bureaू ले गए । यो वाले International
agreement की बातें सारांश की होती हैं । (more accurate)
- Primary standard : विदेशी maintain वाले National laboratories ले गए । अमेरिका वाले Secondary standards
के लिए Verifications calibration गए ।
- Secondary Standard : विदेशी maintain वाले Particular industry ले गए ।
- Working Standard : विदेशी use lab की तरह ।
Instrument की accuracy & performance check करते हैं।

Note IEEE (Institute of Electrical & Electronics
Engineering) : विदेशी विदेशी instrument की
procedure, nomenclature, definition देते हैं।

Q.2) Measurement instruments: विदेशी Physical variable का
Numerical value का change देते हैं।

Q.3) Performance parameter types

(1) Static characteristics : कुछ System के
time का अनुभव Vary होता है ऐसी
To check

- Accuracy → Drift
- precision → Dead Zone
- static error → Linearity
- Resolution → Hysteresis

(2) Dynamic characteristic: ~~स्टेटिक सिस्टम तुम चाहे~~
~~time वाले वायर सिस्टम~~ ~~कैंटर्स वर्स टर्म~~

- Speed of response
- measuring measurement lag
- Fidelity
- Dynamic error.

2.4) Concept of bridges ~~वायर के~~ ~~पर्सनल~~

(i) Wheatstone bridge → Unknown resistance
~~मोड़ाउन्ड~~ ~~वायर के~~ medium ($1\text{ k}\Omega < R < 0.1\text{ m}\Omega$)
 Resistance ~~पर्सनल~~ ~~मोड़ाउन्ड~~ ~~वायर के~~ Galvanometer
 must be null ~~जूहे कैसे~~

(ii) Kelvin's bridge: ~~पर्सनल~~ Galvanometer ~~पर्सनल~~ balanced
~~फ्रेन मॉडल~~ ~~पर्सनल~~ Galvanometer Current (I_g)
 Balanced condition $I_{g1} = E_{th}$, $R_{th} + R_{g1}$

(iii) Maxwell's bridge: ~~पर्सनल~~ Unknown inductance
~~पर्सनल~~ ~~मोड़ाउन्ड~~ ~~जूहे~~ ~~पर्सनल~~ Quality factor must
 $1 < Q < 10$.

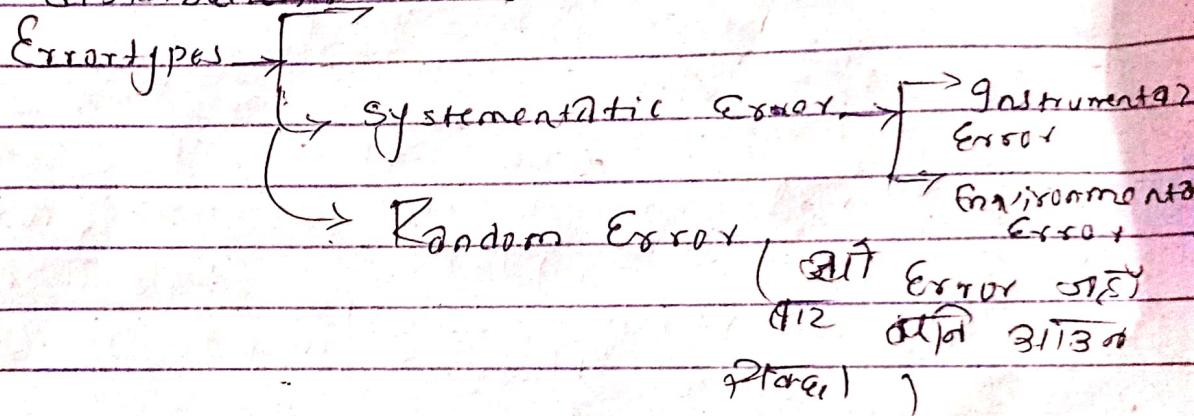
(iv) Hey bridge: ~~पर्सनल~~ ~~पर्सनल~~ Unknown inductance
~~पर्सनल~~ ~~मोड़ाउन्ड~~ ~~जूहे~~ Quality factor (Q) must
 be greater than ~ 10 .

(v) Schering bridge :- ^{प्र० १८} Unknown capacitance
परीक्षण ।

Errors : ~~It means~~ deviate from true value.

$$\text{Probability of Error} = \pm 0.67456 * S$$

Normal distribution :- Gross Error (Human mistake)



Normal distribution :-

formulae

$$Z = \frac{x - m}{6}$$

$X \rightarrow$ Random variable

$m \rightarrow$ mean

6 → standard deviation

$Z \rightarrow$ Standardize value of x .

\Rightarrow ये एक type of Continuous probability distribution for a real valued random variable है।

Unit 3: (physical) Variables & transducer

Physical Variables types

- (3.1) (i) Process variables :- अपने अंतर्गत विशेषज्ञता temp, pressure वरिएल्स आही।
- (ii) Electrical Variables २२१ अंतर्गत Spring, LVDT, thermocouple आही।
- (iii) Mechanical Variables अंतर्गत turbine (linear) to angular ~~or~~ velocity or charge आहे।
- (iv) bio-physical variables : अंतर्गत EMG, ECG आणि EGR आही।

(3.2) (1) Input characteristics of transducer types

- Input type & operating range \Rightarrow range वर्ती कुण्ठाची
- loading effect. \Rightarrow यांची input signal की अवरोध Signal distortion से ३।

(2) Output characteristics of transducer types.

- Electrical output characteristic
- ~~or~~ output impedance
- Output useful range.

Note: (1) resistive transducer.

Eg: Strain gauge, poti, potentiometer, thermometer
Application,

- it is used to measure force, displacement and pressure.
- resistance changes due to change in temp.

(2) Capacitive transducers

$$\text{Eg: Area} \propto C = \epsilon A$$

Area overlapping transducers, cylindrical transducers, change in permittivity due to displacement, change in distance b/w two plates, pressure gauge, dielectric gauge, etc.

Application:

- (i) It is used to measure linear & angular velocity
- (ii) It measures humidity in gases and measure the volume, liquid level, density etc.

(3) Inductive transducer: $L = \frac{\mu A}{R}$ where $R = \frac{L}{\sigma A}$

- Eg:
- (i) by variation of self inductance
 - (ii) by variation of mutual inductance
 - (iii) by production of eddy current

Eg:

LVDT, Voltage & Current (i.e. hall effect),

Note: hall effect: $\frac{\text{Change in current}}{\text{Current}} \propto \frac{\text{Change in magnetic field}}{\text{Magnetic field}}$

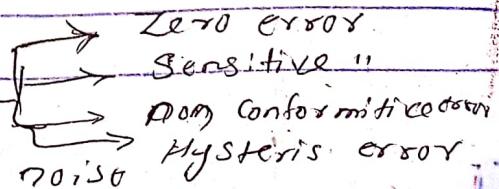
Current carrying conductor in presence of transverse magnetic field is known as hall effect. Application: (i) displacement or if voltage or current, (ii) measuring dynamic motion

3.5 Calibration \Rightarrow अपने instrument primary standard
Secondary Standard \Rightarrow Standardized

Error in transducer types

- (i) Scale error
- (ii) "dynamic"

- (iii) error due to noise



Unit: 04 Signal Conditioning and processing

Page No.

Date: / /

4.1 importance of Signal conditioning

- यहांले Amplifier Voltage or^{is} Amplifier & filter का तरीका है।
- यहांले Output को काफ़िर अंगठी करे Signal को manipulate करे (i.e. Addition, subtraction, integrator, differentiator).

(4.2) Signal amplification, filtering and wave shaping.

(i) Signal amplification :- यहांले लोग voltage

Signal को high voltage Signal HI Convert करे।

(ii) filtering :- यहांले unwanted noise को reduce करे।

(iii) wave shaping :-

4.3 Instrumentation Amplifiers : यहांले यहांले

आपॉले OPAMP. OPAMP use करते, in which high input impedance & high Common mode rejection ratio होते।

4.4

Op Amp

(i) यहांले

Voltage gain
very large होता है (i.e.
(ideally for infinite))

(ii) यहांले

Adder, subtraction,
integrator &
differentiator
e.g. radio, television

Instrumentation amplifier

(i) 212111)

Voltage gain finite
होता है।

(ii) यहांले OPAMP जैसे operation

होता है।

Eg: heart beat, blood pressure.

4.5) Inverting Amplifier: This is just like buffer amplifier (i.e.) feedback resistance (R_f) = 0. So, $A = 1$ and $V_i = V_o$.

(4.6) Amplifier Applications:-

- (i) It is used to increase the power.
- (ii) It is used to current or voltage of signal.
- (iii) It is used in television & radio receivers, audio equipment.

(4.7) Interference Signals & their elimination

~~232~~ Signals ~~at~~ ~~at~~ ~~at~~ Noise ~~at~~ Interference
~~with~~ ~~with~~ ~~with~~ Interference Signals ~~etc.~~
~~therefore~~ ~~therefore~~ ~~therefore~~
 Major path for interference

- (i) Single ~~of~~ Coupled input & output
- (ii) Capacitive Coupling
- (iii) Inductive Coupling
- (iv) ~~RF~~ magnetic Coupling
- (v) RF Coupling.

Elimination

- (i) Direct coupled eliminated by using ground planes, ^{insulated coupling}
- (ii) Capacitive magnetic coupling ^{or} eliminated by using twisted pair.
- (iii) RF coupling eliminated by ~~using~~ ^{distortion} using static shielding.

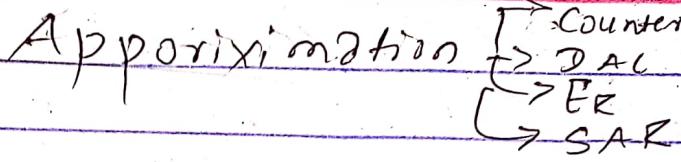
(48) Signal Conversion

Page No.

Date : / /

i) Successive Approximation

Advantages



- (i) more ~~available~~ available
- (ii) easy to fast with ~~the~~ the
- (iii) more accurate

Disadvantage

- (i) cost effective
- (ii) complexity ~~size~~ 1

(ii)

Dual Slope or integrating type ADC

- Opposite polarity
- Integrating
- Comparator
- Digital o/p (counter)
- AND gate.

Time taken by

$$\text{Counter} = (2^N - 1) T = T_1$$

$$\text{Total time} = T_1 + T_2$$

$$T_2 = T_1 = (2^N - 1) T$$

$$\text{Total time} = 2(2^N - 1) T$$

$$= (2^{N+1} - 2) T$$

→ Total time $\propto (2^{N+1}) T$

→ slowest type ADC

→ most accurate ADC

(iii)

Staircase Ramp type (Counting type)

- Counter
- Latch
- DAC
- Comparator
- AND gate

This is basic ADC.
easy to count
Simple circuit

- time Consuming
- input voltage vs time graph
- अवकृति ग्राफ उपरी स्टेप्स

Flash parallel of type ADC

- Comparator → Register $\Rightarrow 2^n$ Registers
 - OPAMP
 - priority Encoder
- (There n is number of bit)

$$\text{Comparator use} = 2^n - 1$$

Easy & Fast ADC

(1)

D to A

$$V_o = \frac{-V_{ref}}{2^n R} \times R_f (D_{n-1} \cdot 2^{n-1} + \dots + D_0 \cdot 2^0)$$

Page No.

Date: / /

$R = 2R$ ladder D to A (2^n V_{ref} - 0 to 1)

→ Inverting OP Amp
Series $\frac{1}{R}$

→ Parallel $\frac{1}{R}$ $2R$

→ more accurate value.

→ easier to build

→ node voltages remain constant with changing input binary words

Disadvantages

8 bit ~~staircase~~ from $R/2R$ up to $8R/2R$

So, this complex circuit

(2) Weighted Resistor Network (WRN)

Advantage

$$V_o = \frac{-V_{ref} \times R_f}{2^{n-1} R} (D_{n-1} \cdot 2^{n-1} + \dots + D_0 \cdot 2^0)$$

Disadvantage

Easy principle / Construction
Fast conversion

Disadvantage

Cost high when increasing the bits
WWRN

WRN

WRN most complicated AD

WRN more expensive -> R =

Unit 6 Output devices

6.1 Indication instruments:

6.2 Types of recorders

- (i) Graphic recorder → Strip chart recorder (x-t)
- (ii) Oscillographic recorder
- (iii) Magnetic tape recorder

(a) Strip chart recorder:-

Horizontal variable time is dependent

Stylus eg: ECG

→ Stylus moves in horizontal & paper moves in vertical

(b) X-y recorder :-

Horizontal variable dependent variable

Independent variable is dependent Styer

Paper moves in stationary
Stylus moves in vertical

Eg: Used in Zener diode, rectifier,
Strain stress curve and
Hysteresis curve.

iii) Magnetic data recorders: 212THI data magnetic form DI record S641
eg: ~~CD~~, ~~DVD~~ tape recorder.

Unit 7

Data Acquisition Systems: 212THI data acquire manipulation & transmission 212THI and 212THI

types:

- i) Analog data acquisition System.
- ii) Digital data acquisition System.

Analog DAS

212THI analog form DI data acquire S641

Uses term

transducer

Signal Conditioning

multiplexor

integral equipment

visual device " calibrating "

Analog recorder

Analog computer

High Speed Computer equipment

Digital DAS

212THI digital form DI data acquire S641

Uses term

transducer

Signal Conditioning

multiplexor

Signal converter

A/D converters

Digital decoder

Auxiliary equipment

Chapter:05 (Data transmission)

5.1) Transmission types:

(iii) Cabled data transmission (types)

(i) Twisted pair :- यह एक दो insulated copper wire spiral form में pattern के लिए जाती है।

- (i) more reliable
 - (ii) easy to work
 - (iii) less cost

Disadvantage.

- (i) less bandwidth
 - (ii) Scap Susceptibility infarcoce

(iii) Co-axial Cable :- both two conductor has same common center is known as Co-axial.

Advantage: (i) more bandwidth

- (ii) less susceptibility in female.

Disadvantages:

- (i) यो दूरी long distance की लाई

-Klephone

- # Expense Log

(iii) Optical cable :- अपनी प्राप्ति Core, cladding & jacketed हो, इसका नाम optical cable होता है।

Advantage

- (i) PDR_{low} bei bandwidths 884

(ii) ~~Ans~~ See ~~Ans~~ Alteration ~~Sec~~

- (iii) inference and facts)

disadvantage : (i) ये दूरी Short distance की तरीके expansive रेस।

(2) Wireless data transmission

(i) Terrestrial Microwave:

- parabolic dish
 - line of sight
 - focused beam
- } ये दूरी तरीके region
ये नहीं सकते

(ii) Satellite microwave: ये दूरी तुलनात्मक

प्रदूरी दूरी ये दूरी उपग्रह वा उपग्रह से। Eg:
long distance phone, TV, private business.

उपग्रह से जिस Signal ने receive की तो
उपग्रह ने उसे transmit किया through Attenuator

(iii) Broadcast Radio: - ये दूरी Omnidirectional रेस। Eg. AM radio

(iv) Infrared: - ये दूरी Infrared light use की Eg. TV remote Control.

Wiring & Optical Cable

Page No.

Date : / /

(5.2) Transmission Schemes : (i) transmitter & receiver both are participant in every time of interval.

(5.3) Data transmission System & Standard

→ 2 types of data link 3rd medium (i) unidirectional
(ii) bidirectional modes of transmission

- (i) parallel / serial modes
- (ii) Simplex / half duplex / duplex mode