UNIT – 4 TRANSDUCERS

EASY QUESTIONS

1.A transducer converting ground movement or velocity to voltage is known as _____
a) Geophone
b) Pickup
c) Hydrophone
d) Sonar transponder
2.Which is the example of a active transducer?
a) Strain gauge
b) Thermistor
c) LVDT
d) Thermocouple
3. Which transducer is known as ‘self-generating transducer
a) Active transducer
b) Passive transducer
c) Secondary transducer
d) Analog transducer
4. What is the relation between scale factor and sensitivity of a transducer?

5.Which of the following is an analog transducer?
a) Encoders
b) Strain gauge
c) Digital tachometers
d) Limit switches
6.What is the principle of operation of LVDT?
a) Mutual inductance
b) Self-inductance
c) Permanence
d) Reluctance
7.Which of the following can be measured using Piezo-electric transducer?
a) Velocity
b) Displacement
c) Force
d) Sound
8.Capacitive transducer are used for?
a) Static measurement
b) Dynamic measurement
c) Transient measurement
d) Both static and dynamic
.9. Which of the following is used in photo conductive cell?
a) Selenium
b) Quartz

c) Rochelle salt
d) Lithium sulphate
10.Mechanical transducers sense _____
a) electrical changes
b) physical changes
c) chemical changes
d) biological changes
11.Mechanical transducers generate _____
a) electrical signals
b) chemical signals
c) physical signals
d) biological signals
12.Electrical transducers generate _____
a) biological signals
b) chemical signals
c) physical signals
d) electrical signals
13.The power needs of electrical transducers is _____
a) maximum
b) minimum
c) zero
d) infinite
14.Electrical transducers are _____
a) small and non-portable
b) large and non-portable
c) small and compact
d) large and portable
15.Potentiometer transducers are used for the measurement of
A. Pressure
B. Displacement
C. Humidity
D. Both (a) and (b)
16.Thermistor is a transducer. Its temperature coefficient is
A. Negative
B. Positive
C. Zero
D. Unique
17.Strain gauge is a
A. Active device and converts mechanical displacement into a change of resistance
B. Passive device and converts electrical displacement into a change of resistance
C. Passive device and converts mechanical displacement into a change of resistance
D. Active device and converts electrical displacement into a change of resistance
18.The linear variable differential transformer transducer is
A. Inductive transducer

B. Non-inductive transducer
C. Capacitive transducer
D. Resistive transducer

1. With the increase in the intensity of light, the resistance of a photovoltaic cell
A. Increases
B. Decreases
C. Remains same
D. Doubled
2. If the displacement is measured with strain gauge then the number of strain gauge normally required are
A. One
B. Two
C. Three
D. Four
3. LEDs fabricated from the gallium arsenide smit radiation in the
A. Visible Range
B. Infrared Region
C. Ultra violet Region
D. Ultrasonic Region
4. In light emitting diode, the available light emitting region is
A. Less than 2.5 mm
B. From 2.5 to 25 mm
C. Greater than 25 mm
D. Greater than 50 mm
5. In liquid crystal displays, the liquid crystal exhibits properties of
A. Liquid
B. Solids
C. Gases
D. Both (a) and (b)
6. The optical properties of liquid crystals depend on the direction of
a) Air
b) Solid
c) Light
d) Water
7. LCDs operate from a voltage ranges from
a) 3 to 15V
b) 10 to 15V
c) 10V
d) 5V
8. LCDs operate from a frequency ranges from
a) 10Hz to 60Hz
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9. What is backplane in LCD?
a) The ac voltage applied between segment and a common element
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a) Cathode
b) Anode
c) Grid
d) Body
11.LDR's are also called_____
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12. In dark, LDR has
A. low resistance
B. high current
C. high resistance
D. both A and B

31. 1 eV is equal to
A.1.6×10^{-19} J
B. 2.0×10^{-20} J
C. 3 J
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32.Solar cell works based on
(a) Laser technology (b) Photo-conduction (c) Thermal emission (c) Tyndall effect
33.Commonly used photoemissive material is _____
a) gold
b) opium
c) tellurium
d) cesium-antimony
34.Photoconductors are made of _____
a) thick layer of semiconductor
b) thin layer of semiconductor
c) capacitive substrate
d) inductive substrate
35.A device consists of a phototransistor and a led is

A. Photodiode

B. Optocoupler

C. Optoisolator

D. Photomultiplier

36.A load cell is essentially a

(a) strain gauge (b) thermister (c) resistive potentiometer (d) inductive transducer

12. A half wave rectifier has an input voltage of 240 V rms if the step down transformer has turns ratio of 8:1, what is the load voltage?
(a)27.5v (b)86.5v (c)30v (d)42.5V
Answer: D

TOUGH QUESTIONS

1. Reverse saturation current in silicon PN junction diode nearly doubles for every
(a) 20°C rise in temperature (b) 50°C rise in temperature
(c) 60°C rise in temperature (d) 10°C rise in temperature
Answer: D

2. If, by mistake ac source in a bridge rectifier is connected across the dc terminals it will burn out and hence short_____diodes
(a) One (b) Two (c) Three (d) Four
Answer: D

3. A Voltage of 200V produces a deflection of 90^o in PMMC spring controlled instrument. If the same instruments provided with gravity control,what would be the deflection?
a)90^o b) 45^o c) 64.2^o d) 98^o
Answer: B

4. In plate earthing the earth plate made up of copper size
a)60cm*60cm*3.18mm b)70cm*80cm*3.18mm c)80cm*65cm*3.18mm d)90cm*60cm*3.18mm
Answer: A

5. A moving coil instrument gives a full scale detection of 20mA.When a potential difference of 50mV is applied. Calculate the series resistance to measure 500V on scale?
a)2000ohm b)3000ohm c)3500ohm d)24997.5ohm
Answer: D

6. The applied input ac power to a half wave rectifier is 100 watts. The d.c output power obtained is 40 watts. What is the rectification efficiency?
(a)10% (b)20% (c)30% (d)40%
Answer: D

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Answer:A

4. What is the relation between scale factor and sensitivity of a transducer?
a) Scale factor is double of sensitivity
b) Scale factor is inverse of sensitivity
c) Sensitivity is inverse of scale factor
d) Sensitivity is equal to scale factor
Answer: B

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D. Photomultiplier
Answer:B
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(a) strain gauge (b) thermister (c) resistive potentiometer (d) inductive transducer
Answer:A

UNIT – 5 DIGITAL SYSTEMS

EASY QUESTIONS

1. Communication is the transfer of meaningful information from
(a) source to destination (b) transmitter to receiver
(c) sender to receiver (d) above all

ANSWER:D

2.The basic process of information exchange between transmitter and receiver is known as…..
(a) communication (b) controlling (c) signaling (d) modulating
ANSWER:A

3. The process of converting electrical equivalent of the information to a suitable form is done by….
(a) transmitter (b) receiver (c) medium (d) above all
ANSWER:A

4. The communication system with wire as conducting medium is known as ……
(a) wired communication (b) line communication
(c) guided media communication (d) above all
ANSWER:D

5.The communication system which has no wires as conducting medium is known as…..
(a) wireless communication (b) radio communication
(c) unguided communication (d) above all
ANSWER:D

6. Noise is basically a……
(a) random signal (b) unwanted electrical signal
(c) disturbance signal (d) above all
ANSWER:D

7. The process of varying amplitude of sine wave carrier signal according to the instantaneous voltage of sine wave modulating signal is known as ….
(a) Frequency Modulation (b) Phase modulation
(c) Amplitude modulation (d) PAM
ANSWER:C

8. The loss of information in AM wave is known as…
(a) under modulation (b) over modulation
(c) attenuation (d) rectification
ANSWER:B

9. Each product term of a group, a'.b.c' and a.b, represents the _____in that group.
a) Input
b) POS
c) Sum-of-Minterms
d) Sum of Maxterms
ANSWER:C

10. Each “1” entry in a K-map square represents:
a) A HIGH for each input truth table condition that produces a HIGH output
b) A HIGH output on the truth table for all LOW input combinations
c) A LOW output for all possible HIGH input conditions
d) A DON’T CARE condition for all possible input truth table combinations
ANSWER:A

11. Which of the following expressions is in the sum-of-products form?
a) (A + B)(C + D)
b) (A * B)(C * D)
c) A* B *(CD)
d) A * B + C * D
ANSWER:D

12. K-Map of full adder is of ------ variables
A. 2 b. 3 c.4 d.1
ANSWER:B

13. The output of a logic gate is 1 when all its inputs are at logic 1, the gate is either
(a) A NAND or a NOR
(b) An AND or an OR
(c) An OR or an X-OR
(d) An AND or a NOR
ANSWER:B

14. The output of a logic gate is 1 when all its inputs are at logic 0. The gate is either
(a) A NAND or a NOR
(b) An AND or an X-OR
(c) An OR or a NAND
(d) An X-OR or an X-NOR
ANSWER:A

15. The most suitable gate to check whether the number of 1’s in a digital word is even or odd is
(a) X-OR (b) NAND (c) NOR (d) AND, OR and NOT
ANSWER:A

16. The number of rows in the truth table of a 4- input gate is,
(a) 4 (b) 8 (c) 12 (d) 16
ANSWER:D

17. For checking the parity of a digital word, it is preferable to use
(a) AND gates (b) NAND gates (c) X-OR gates (d) NOR gates
ANSWER:C

18. A+AB+ABC+ABCD+ABCDE…. =
(a) 1 (b) A (c) A+AB (d) AB
ANSWER:B

MODERATE QUESTIONS

1. A swithching function F(a,b,c,d)=a'b'cd+a'bc'd+a'bcd+ab'c'd+ab'cd
a. ∑m(1,2,4,5,7) b. ∑m(3,5,7,9,13) c. ∑m(3,5,7,9,11) d. ∑m(3,7,9,11,13)
ANSWER: C

2. The function F(a,b,c,d)= ∑m(5,9,11,14) is equivalent to
a. a'bc'd+ab'c'd+ab'cd+abcd'
b. a'b'c'd+ab'c'd'+ab'cd+ab'cd'
c. a'bc'd+ab'c'd+abcd+ab'cd'
d. a'bc'd+a'b'c'd+ab'cd+a'bcd'
ANSWER:A

3. If SOP form of the function F= a'bc'd+ab'c'd+abcd+ab'cd'
a. F=(a+b'+c+d')(a'+b+c+d')(a'+b'+c'+d')(a'+b+c'+d)
b. F=(a+b'+c+d)(a'+b'+c+d')(a'+b'+c'+d')(a'+b'+c'+d)
c. F=(a'+b'+c+d')(a'+b+c+d')(a+b'+c'+d')(a'+b+c+d)
d. F=(a+b'+c'+d')(a'+b+c+d')(a'+b'+c'+d')(a'+b+c'+d')
ANSWER: A

4. If a 3 variable function is represented in POS form as πM(0, 3,6,7) then in SOP from it is represented as
a. ∑m(1,2,4,6) b. ∑m(1,3,4,5) c. ∑m(1,2,4,5) d. ∑m(1,2,4,7)
ANSWER:C

5. Q.96.A+B=B+A; AB=BA represent which laws
(a) Commutative
(b) Associative
(c) Distributive
(d) Idempotence
ANSWER:A

6. The K-map based Boolean reduction is based on the following Unifying Theorem: A + A' = 1.
a) Impact
b) Non Impact
c) Force
d) Complementarity
ANSWER:B

7. The prime implicant which has at least one element that is not present in any other implicant is known as _____

a) Essential Prime Implicant
b) Implicant
c) Complement
d) Prime Complement
ANSWER:A

8. Product-of-Sums expressions can be implemented using _____
a) 2-level OR-AND logic circuits
b) 2-level NOR logic circuits
c) 2-level XOR logic circuits
d) Both 2-level OR-AND and NOR logic circuits
ANSWER:D

9. There are many situations in logic design in which simplification of logic expression is possible in terms of XOR and _____ operations.
a) X-NOR
b) XOR
c) NOR
d) NAND
ANSWER:A

10. These logic gates are widely used in _____ design and therefore are available in IC form.
a) Sampling
b) Digital
c) Analog
d) Systems
ANSWER:B

11. In cellular transmitter system, the carrier generated by frequency synthesizer uses following modulation by the amplified voice signal from microphone
(a) Frequency modulation (b) Phase modulation
(c) AM modulation (d) None of above
ANSWER:B

12. The modulation index corresponding to maximum deviation and maximum modulating frequency is called as…
(a) modulation index (b) deviation ratio
(c) pre-emphasis factor (d) de- emphasis factor
ANSWER:B

TOUGH QUESTIONS

1) Reduce the expression y=a’b’c’d+a’bc’d+a’bcd+a’bcd’+abc’d’+abc’d+abcd+ab’cd
a) acd+ a’cd+ab’c+a’b’c’
b) a’c’d+a’bc+abc’+acd
c) a’c’d+abc+abc’+a’c’d’
d) ac+a’bc+abc’+acd
ANSWER : B

2) simplify the function f(a,b,c)= ∑m(0,3,4,7)
a) b’c’+bc
b) a’b’+bc
c)a’b’+ab
d)ab’+bc
ANSWER: A

3) (A + B)(A’ * B’) = ?
a) 1
b) 0
c) AB
d) AB’
ANSWER:B

4. Simplify Y = AB’ + (A’ + B)C.
a) AB’ + C
b) AB + AC
c) A’B + AC’
d) AB + A
ANSWER:A

5. The boolean function A + BC is a reduced form of _____
a) AB + BC
b) (A + B)(A + C)
c) A’B + AB’C
d) (A + C)B
ANSWER:B

6. The canonical sum of product form of the function y(A,B) = A + B is _____
a) AB + BB + A’A
b) AB + AB’ + A’B
c) BA + BA’ + A’B’
d) AB’ + A’B + A’B’
ANSWER:B

18EES101J - BASIC ELECTRICAL AND ELECTRONICS ENGINEERING.

UNIT - IV

TRANSDUCERS

* Tranducer functions and Requirements.
* classification Active and Passive
* Displacement : capacitive, Inductive, Variable Inductance.
* Linear Variable Differential Transformer
* Electromechanical : Pressure, Flow, Accelerometer Potentiometer etc..
* Strain Gauge
* chemical : pH probes, Electro galvanic sensor etc..
* Electroacoustic : MIC, Speaker, Piezo electric, sonar, ultrasonic
* Tactile, Geophones, Hydrophones
* Electro optical : LED, Laser, Photodiode, Photoresistor, Phototransistor
* Photo conductive cell, Photovoltaic cell, Solar cell.
* LED, infrared emitters, LCD, optocouplers
* Thermoelectric : Resistance Temperature Detectors
* Thermo couple * Thermistor * Electrostatic : Electrometer
* Electromagnetic : Antenna, Hall effect, Magnetic catridge etc..
* Radioacoustic : Geiger Muller, Radio receiver, Radio transmitter.

Transducer:-

A transducer is a device which converts the energy from one form to another form. This energy may be electrical, mechanical, chemical, optical or thermal.

The transducer that gives electrical energy as output is known as electrical transducer.

O/P electrical signal may be voltage, current or frequency and production of these signals is based upon resistive, capacitive, inductive effects.

For measuring non-electrical quantities, a detector is used which usually converts the physical quantity into a displacement.

The displacement transducers converts mechanical force into displacement and then into electrical parameters. Here the mechanical elements used for converting this applied force into displacement are called force summing devices.

Transducer

Active

↓

Self Generating type, develop their own voltage or current

Passive

Externally powered transducers, derive power from external source.

* opto electronic transducer such as photoconductive cell, use the principle of converting light energy to electrical energy

Basic Requirements of a transducer:

i) Linearity:-

The i/p - o/p characteristics of the transducer should be linear.

ii) Ruggedness:

The transducer should withstand overloads, with measures for overload protection.

iii) Repeatability:-

The transducer should produce identical o/p signals when the same i/p is applied at different times under same environmental conditions.

iv) High stability and Reliability.

The o/p from the transducer should not be affected by temperature, vibration and other environ-mental variations and there should be minimum error in measurements.

v) Good Dynamic response:-

In Industrial, aerospace and biological applications, the i/p to the transducer will not be static but dynamic in nature, ie., the i/p will vary with time. The transducer should respond to the change in i/p as quickly as possible.

vi) Convenient Instrumentation:-

The transducer should produce a sufficiently high analog o/p signal with high S/N ratio, so that the

o/p can be measured either directly or after suitable amplification.

vii) Good Mechanical characteristics:

The transducer, under working conditions, will be subjected to various mechanical strains. Such external forces should not introduce any deformity and affect the performance of the transducer.

Examples of Active and Passive transducers:-

Active Transducers	Passive Transducers.
i) Thermocouple	i) Resistance
ii) Piezoelectric transducer	ii) Potentiometric devices
iii) Photovoltaic cell	iii) Resistance strain gauge
iv) Moving coil generator	iv) Resistance thermometer
v) Photoelectric cell	v) Thermistor
	vi) Photoconductive cell
	vii) Inductance
	viii) LVDT
	ix) Capacitance
	x) Voltage and current devices using Hall effect.
	xi) Photo emissive cell
	xii) Photo Multiplier tube.

CAPACITIVE TRANSDUCER:-

The capacitance of a ||el plate capacitor is given by

$$C = \varepsilon_0 \varepsilon_r \frac{A}{d}$$

Where, A = Area of each plate / m^2

d = distance b/w ||el plates in m

ε_0 = dielectric constant → Permittivity of free space. in F/m

ε_r = Relative dielectric constant (Permittivity)

$X_L = \omega L$

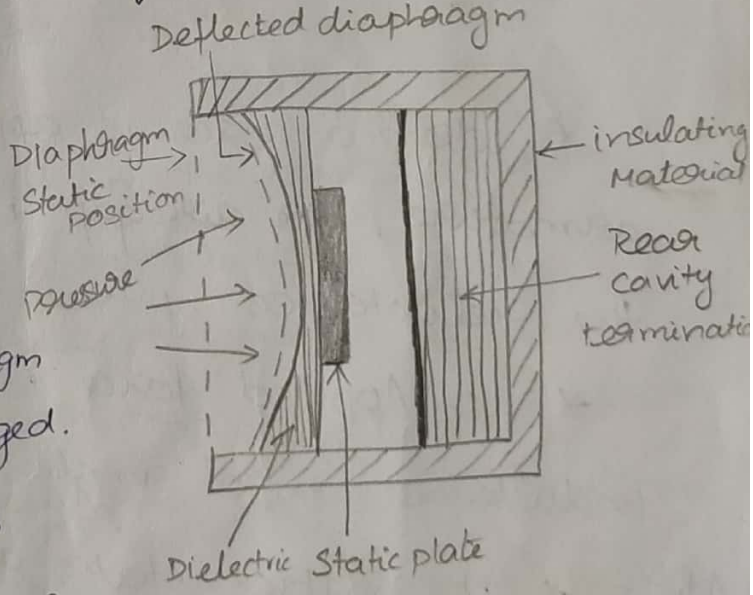
$X_C = \frac{1}{\omega C}$

The capacitance is ∝ Area of plate ⇒ $C \propto A$.

$$C \propto \frac{1}{d},$$

∴ Any variation in A or d causes variation in capacitance.

This principle of variation of d is used in capacitive transducer.



* When a force is applied to a diaphragm which acts as one plate of capacitor, the distance b/w the diaphragm and the static plate is changed.

* The Resulting Changed is measured with AC bridge or an oscillator.ckt.

* The oscillator ckt measures the change in frequency which is a measure of the magnitude of applied force.

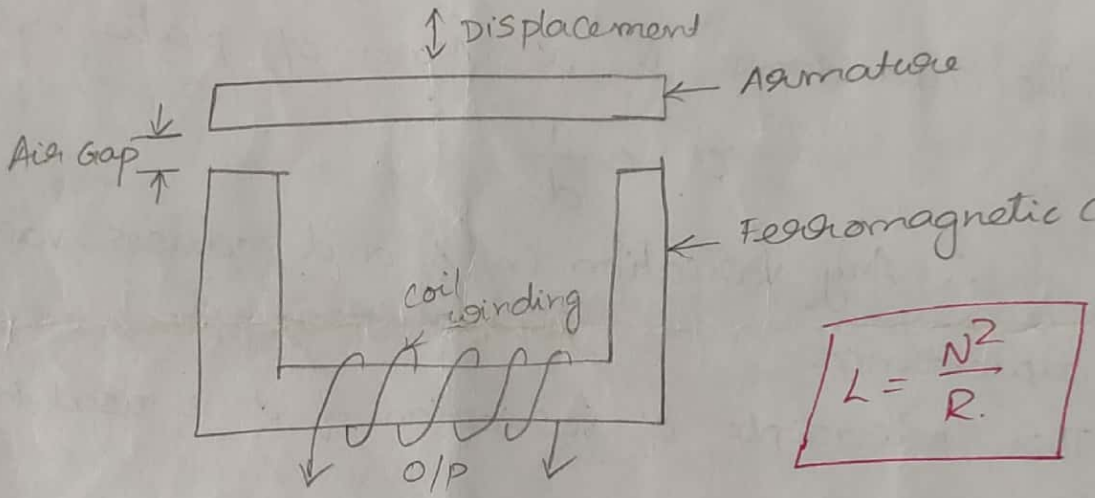
* In capacitor microphone, the same principle is used in which sound pressure varies the capacitance blw the fixed plate and a movable diaphragm.

Adv:* The capacitive transducer can measure both static and dynamic changes.

Drawback:-

* It is sensitive to temperature variations.

Inductive Transducer:-



* When a force is applied to the ferromagnetic armature, the air gap is changed thereby varying the reluctance of the magnetic ckt.

* ∴ Applied force is measured by change in inductance in a single coil.

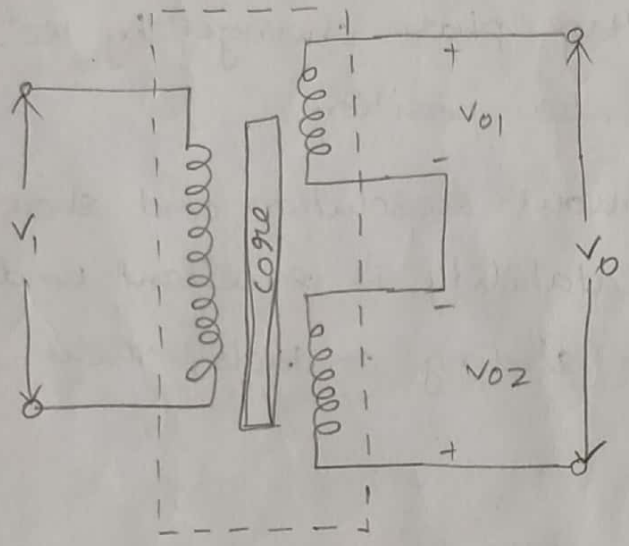
Adv:- * It enables static and dynamic measurements

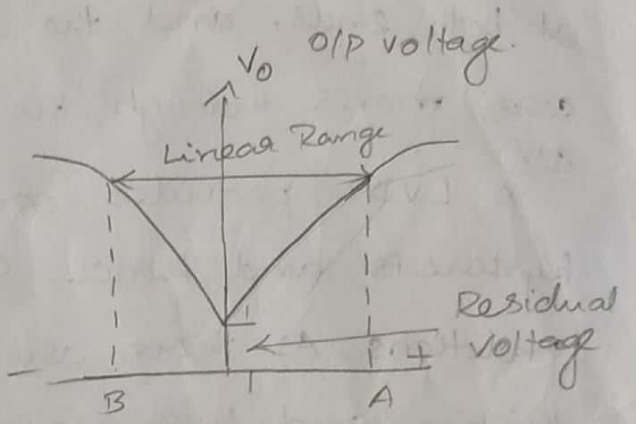
Drawback:-

It has limited frequency response.

Linear Variable Differential Transformer (LVDT)

* LVDT is most widely used inductance transducer.





* It consist of a primary coil and two exactly similar secondary coils with a rod shaped magnetic core positioned centrally inside the coil.
* An alternating current is fed into the primary and voltages V_{01} and V_{02} are induced in the secondary coils.
* As these coils are connected in series opposition, the O/P voltage $V_0 = V_{01} - V_{02}$.
* If the core is placed ideally in the central position, $V_{01} = V_{02}$ and hence the O/P voltage $V_0 = 0$.
* In practice due to incomplete balance, a residual voltage usually remains with the core in this position.
* When the core is displaced from the null position, the induced voltage in the secondary towards which the core has moved increases while that in the other secondary decreases.
* This results in a differential voltage output from the transformer.

* The o/p voltage produced by the displacement of the core is linear over a considerable range but flattens out at both ends, and the voltage phase changes by 180°. as the core moves through the center position.

Adv :-

* LVDT provides continuous resolution and shows low hysteresis and hence, repeatability is excellent under all conditions. As there are no sliding contacts, there is less friction and less noise.

Disadvantages:-

* It is sensitive to vibrations and temperature.
* The receiving instrument must be selected to operate on ac signals. or a demodulator network must be used if a dc output is required.

Thermistor:

* The thermistor or thermal resistor is a two-terminal semiconductor device whose resistance is temperature sensitive.
* The value of the resistors ↑ses with ↓se in temperature.
* Materials for thermistor :- cobalt, nickel, copper iron, uranium, manganese.
* The thermistor has very high temperature co-efficient of resistance, making it an ideal temperature transducer.

It is of the order 3 to 5 % Per °c

* The temperature co-efficient is normally negative.

* The resistance at any temperature T, is given approximately by.

$$R_T = R_0 \exp \beta\left(\frac{1}{T} - \frac{1}{T_0}\right)$$

where,

R_T → thermistor resistance at temperature T(k),

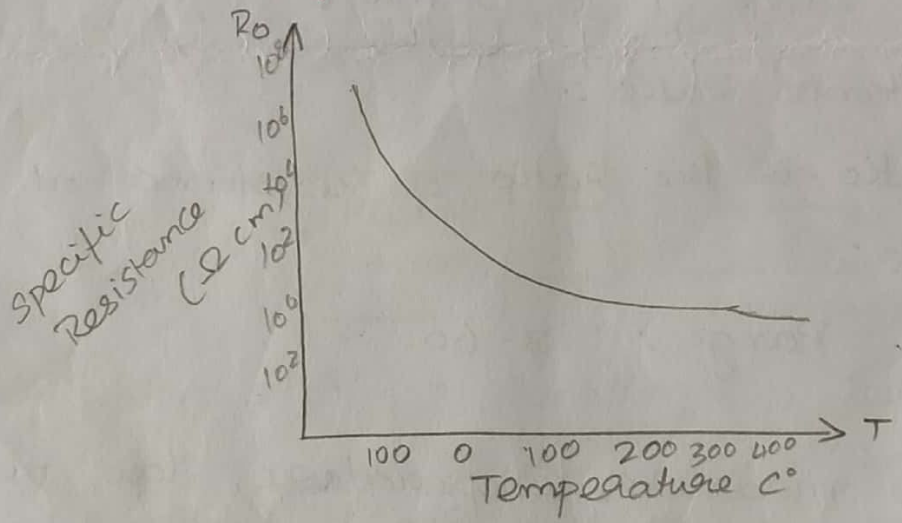
R_0 → thermistor resistance at temperature T_0(k),

β → a constant determined by calibration.

At high temperatures, the equation reduces to

$$R_T = R_0 e^{(\beta/T)}$$

Resistance - temperature curve:



* The curve is non-linear, the drop in resistance from 5000 to 10Ω occurs for an increase in temperature from 20 to 100°C.

* The temperature of the device can be changed internally or externally.

eg: Increase in current ↑se the temperature of the device and thus the resistance decreases.

Externally applied heat source will increase the temperature and thus resistance drops.

Parameter characterizing Thermistor.

i) Time constant :-

The time constant is the time for a thermistor to change its resistance by 63% of its initial value for zero - power dissipation.

Range :- 1 to 50s.

ii) Dissipation constant :-

The dissipation factor is the power necessary to increase the temperature of thermistor by 1°C

Range : 1 to 10 mW/C°

iii) Resistance Ratio :-

Resistance Ratio is the ratio of resistance at 25°C to that at 125°C.

Range :- 3-60.

Uses :-

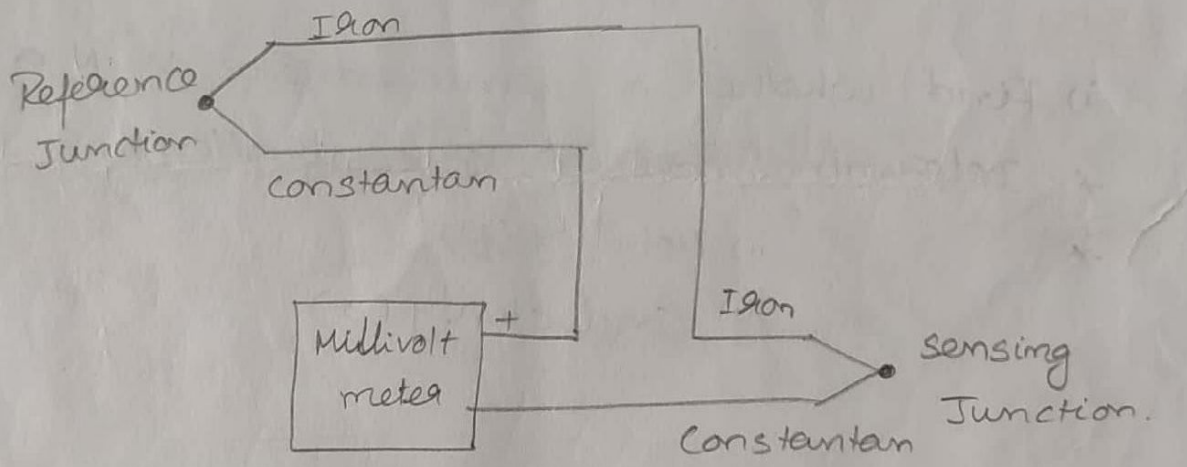
* used to measure, temperature, flow, pressure, liquid level, voltage (or) power level, vacuum, composition of gases and thermal conductivity.
* In compensation n/w.

Thermocouple :-

* A thermocouple is a Junction b/w two dissimilar metals (or) semiconductors that generates a small voltage, typically in the millivolt range, with co-efficient of about 50 μV/C°.

* various thermocouple materials and methods of construction are used depending upon the temperature, environment and required sensitivity.

Thermocouple circuits :-



* It Consist of 2 Junctions i) Reference
ii) sensing;
maintained at different temperatures.

* Each Junction is made up of 2 dissimilar metals

* Reference Junction is maintained at constant temp say 0°C

* o/p voltage depends upon the temperature of sensing junction.

* o/p is very small volt; so it is necessary to amplify the o/p for calibration and measurement.

Uses:

Iron - constantan thermocouple → measuring temp upto 760°c.

Chromel - Alumel thermocouple → measuring temp upto 1370°c

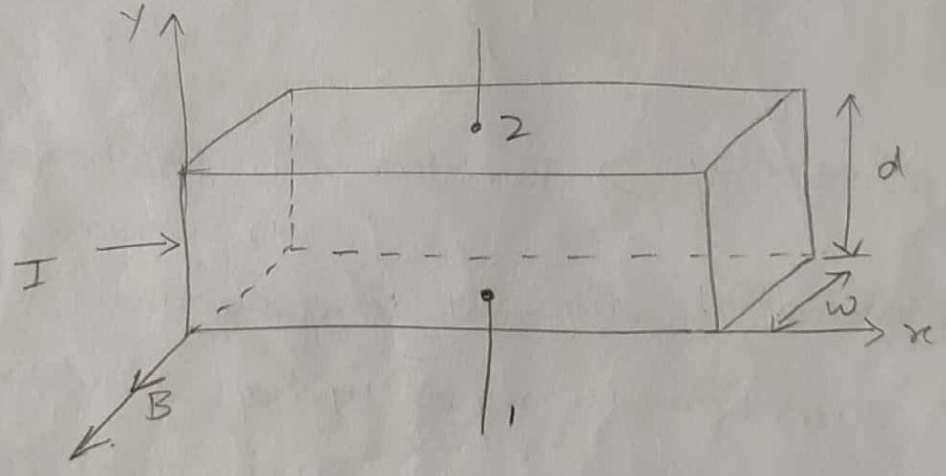
Hall effect:

* When a transverse magnetic field B is applied to a metal or a semiconductor carrying a current I, an electric field E is induced in the direction perpendicular to both I and B. This phenomenon is known as Hall effect.

Uses:

i) Find whether a semiconductor is N or P type

* Determine i) carrier concentration.
* ii) Mobility (μ)
  iii) Conductivity (σ).



The Force given,

$$F = eE = Bev$$

e → charge of e^-
B → magnetic field
V → drift velocity.

In N-type semiconductor:-

* The current is carried by electrons.
* It will be forced downwards towards side 1
* So 1 becomes negatively charged with respect to 2.

$\therefore$ Hall Voltage, $V_H = \frac{R_H}{w} BI.$

$R_H \rightarrow$ Hall co-efficient $\Rightarrow R_H = \frac{1}{\rho}$

$w \rightarrow$ width of conductor. $\rho \rightarrow$ charge density.

$\rho = ne \rightarrow n \rightarrow$ electron concentration.

Ptype semiconductor:-

* If the polarity of V_H is positive at terminal 1 with respect to terminal 2.

$\rho = pe$, $p \rightarrow$ hole concentration.

conductivity :- $\sigma = \rho\mu.$

$\mu = \sigma R_H.$

Advantages:-

* They are non contact devices, with high resolution and small in size.

Other applications:-

* Measurement of velocity, RPM, sorting, limit sensing, non-contact current and magnetic field.

STRAIN GAUGE:-

* If a metal conductor is stretched or compressed, its resistance changes because of dimensional changes (l and and cross sectional A) and resistivity change.

* If a wire is under tension its length ↑se from

$$l \rightarrow l + \Delta l.$$

$$R \rightarrow R + \Delta R$$

$$\therefore \text{Strain } S = \frac{\Delta l}{l}$$

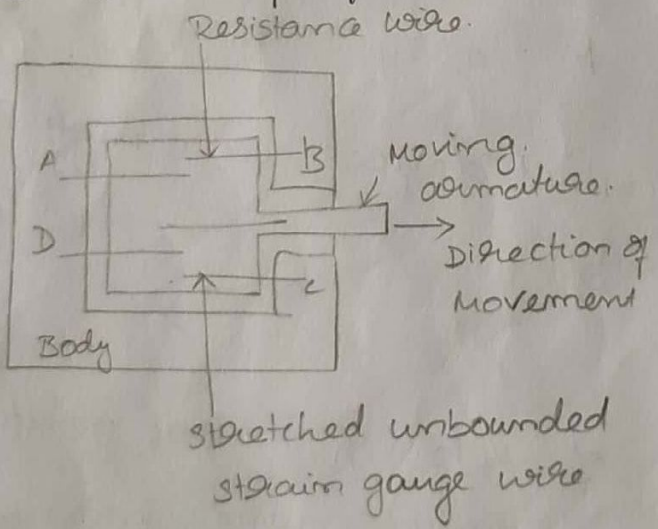
* The sensitivity of a strain gauge is described in terms of a characteristic called gauge factor G,

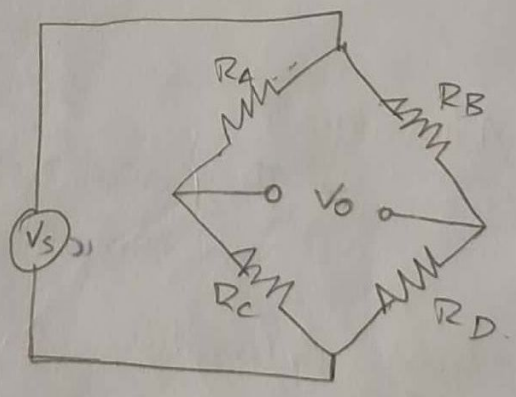
$$G = \frac{\Delta R/R}{\Delta l/l} = \frac{\Delta R/R}{S}$$

Gauge factor G, is defined as the unit change in resistance per unit change in length.

i) unbonded strain Gauge.

The unbonded strain gauge have unbonded wire structure fixed to a force rod which transmiting force to the platform.





* The resistance wire have equal length.

* The armature moves in any one direction.

* Because of the movement of armature the length of the resistance wire A and D ↑ses in length. whereas element B and D decreases in length.

* AS the length varies, Resistance of 4 wires changes and this can be measured with a wheatstone bridge.

* unbalancing the bridge creates the o/p voltage Vo.

Balancing condition of bridge $\Rightarrow \frac{R_A}{R_C} = \frac{R_B}{R_D}$.

* The external force causes variation in resistance of wires

ii) Bonded wire strain gauge:

* A bonded wire strain gauge consists of a grid of fine resistance wire of diameter of about 25 μm. The wire is cemented to base.

* The base may be a thin sheet of paper or very thin Bakelite sheet.

* The wire is covered with a thin sheet of material so that it is not damaged mechanically.

* The base is bonded to the structure under study with an adhesive material.

* It acts as a bonding material.

* It permits a good transfer of strain from base to wire.

Potentiometer:

It is a variable resistor, Types i) carbon
ii) wire wound.

i) carbon potentiometer:

* The construction of carbon potentiometer is as in fig.

* These are manufactured either in film or moulded track types.

* Both consist of an annular ring of carbon resistance formed on a plastic base, over which a movable contact can slide

* There is a slip ring which is also contacted by the movable contact.
* Three terminals are provided, two of them connected to the ends of the carbon track and one to the slip ring.
* A shaft runs through a bush in the center of the base to which the movable contact is attached.
* The assembly is enclosed by a case of sheetmetal over which the resistance value and taper is engraved.
* The taper refers to variation in resistance along the track, which may be i) logarithmic
ii) Linear variation.

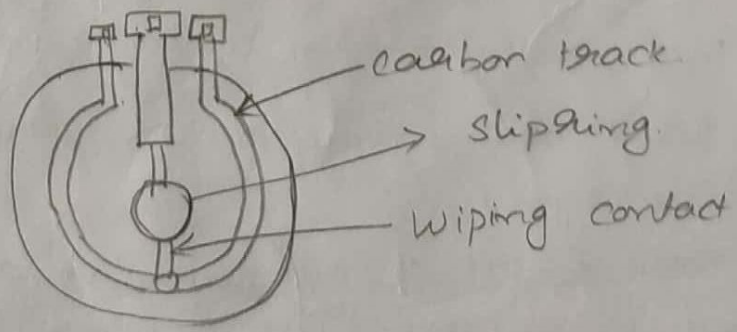
The Track can be film type (or) moulded type.

i) Film type :- A mixture of carbon, graphite and resin in the form of paste is sprayed on to a plastic sheet, with suitable masks in the form of rings.

If non-linear taper is required, the ring width may be varied across the circumference or the spray may be made from different composition mixture.

ii) Moulded track type :- The resistance material and base plate are moulded together with slip ring.

This integral moulding of base, track and terminals gets rid of solders, rivets, weld and provide good humidity resistance and fewer mechanical joints.



ii). Wire wound potentiometers :

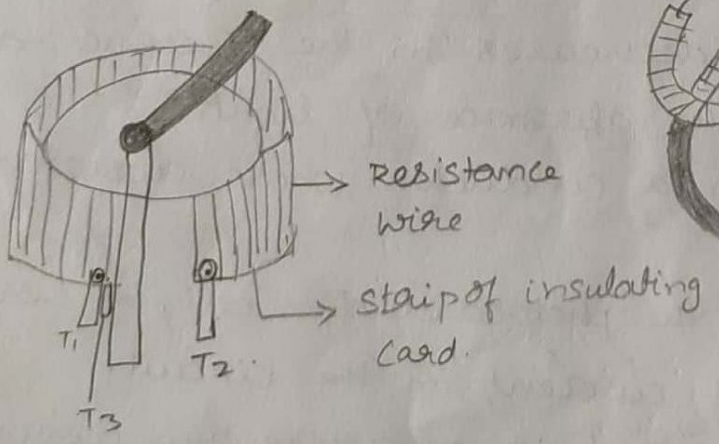
There are 2 types a) single turn
b) Multi turn

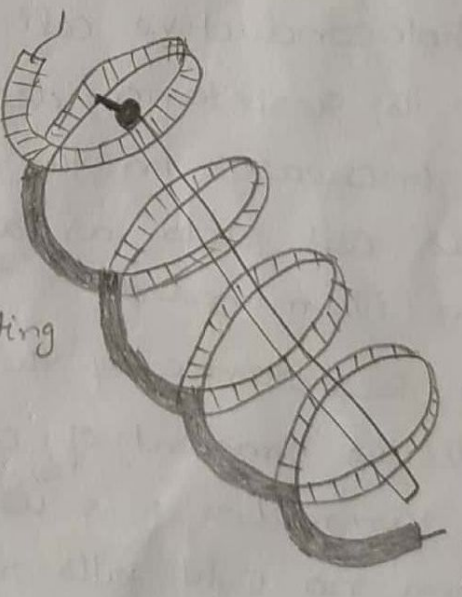
a) single turn :-

* It consist of a flat strip of insulating card made of flexible plastics or anodised aluminium.
* The resistance wire are made up of
  - Copper alloy → Low resistance pots
  - nicked chromium → High resistance pots,

is wound and then the strip is bent round.
* contact by means of a slider metal or beryllium copper, which is spring loaded
* Contact from the slider is made through a slip ring or by a coiled spring.
* The winding is usually of two or three linear resistance sections.
* singleturn pots → Range : 50Ω to 5MΩ
  Power Rating : 2 to 3 W.

uses :-
* used as Gain control element in an amplifier
* AS brightness and contrast control in TV receivers.





b) Multiturn wire wound :-

* Multiture or helical pots have up to 10 turns

* The resistance element is wound on a long strip and then formed into a helix
* The contact is of precision metal and has multiple "fingers". The groove between the helical turns of the element used to guide the contact.
* Because of its construction, the wire wound pot has appreciable stray inductance and capacitance.
* Multi turn pots :- Range :- 50Ω to 250kΩ.
Power Rating :- 5W.

uses:-
used in applications that require precise setting of resistance value.

OPTO ELECTRONIC DEVICES

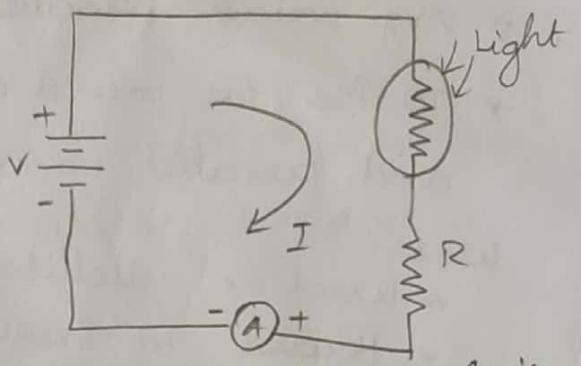
i) Photo conductive cell

* Photo conductive cell or Light Dependent Resistor (LDR)
* It is made of a thin layer of semiconductor material such as cadmium sulfide or lead sulfide.
* The semiconductor layer is enclosed in a sealed housing.
* A glass window in the housing permits light to fall on the active material of the cell.
* Photoconductive cell exhibits the peculiar property that its resistance decreases in the presence of light and increases in the absence of light.
* This cell acts as a conductor whose resistance changes when illuminated.
* The Resistance of the photoconductive cell, in series with R limits the amount of current in the circuit.
* The ammeter A is used to measure the current.
* When no light falls on the cell, its resistance is very high and current is low.

* The voltage drop V_0 across R is relatively low.
* When the cell is illuminated, its resistance becomes very low
* The current increases and voltage V_0 increases.

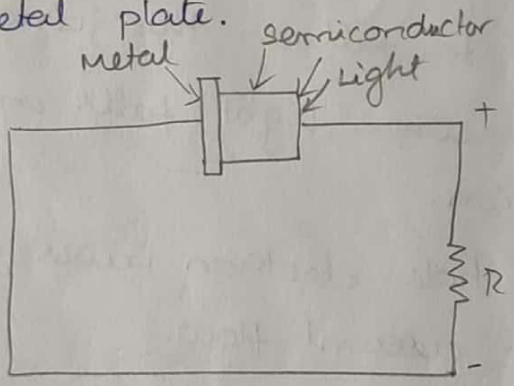
*Uses:-

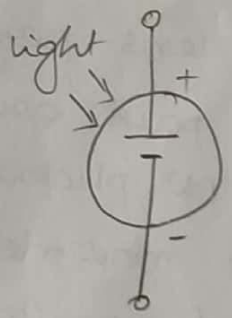
This simple ckt with slight modifications can be used in control circuits to control the current.



Photovoltaic cell:-

* Photovoltaic cell, is light-sensitive semiconductor device, produces a voltage when illuminated which may be used directly to supply small amount of electric power.
* The voltage rises as the intensity of light falling on the semiconductor junction of this cell rises.
* The cell consist of a piece of semiconductor material such as silicon, germanium or selenium which is bonded to a metal plate.





Solar cell:-

* When sun light is incident on a photovoltaic cell, it is converted into electric energy.
* Such a energy converter is called solar cell or solar battery.
* This cell consist of a single semiconductor crystal which has been doped with P and N type materials.
* When light falls on the PN junction, a voltage

appears across the junction.

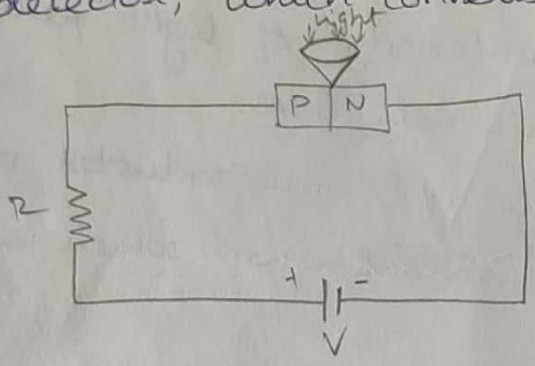
* About 0.6V is developed by the solar cell in bright sunlight.
* Avg power produced by a cell → 30 mW / sq m
* To use the power o/p, banks of cells are used in series and parallel combinations.

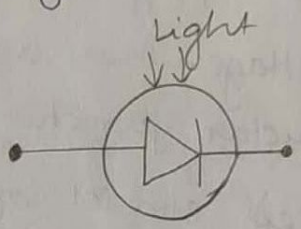
Uses:-

* used in satellites.
* Houses to harvest electrical power.

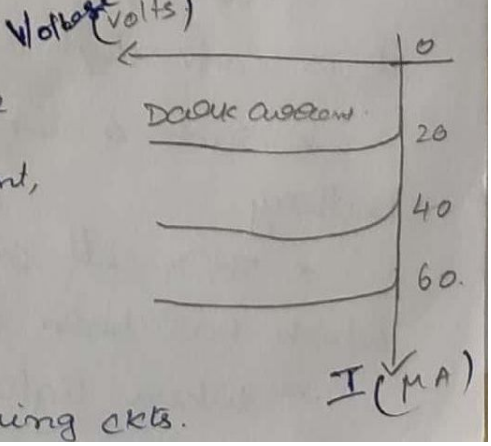
Photodiode :- (Photo detector):-

* Silicon photodiode is a light sensitive device, also called photodetector, which converts light signals to electrical signals





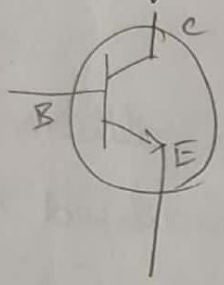
* The lens permits light to fall on the junction, hole-electron pair are created when light falls on reverse biased PN photodiode junction.
* The movement of these hole-electron pairs in a properly connected circuits results in current flow.
* $I \propto$ Intensity of light
* The reverse current increases in direct proportion to the level of illumination.
* Even when no light is applied, there is a minimum reverse leakage current, called dark current.

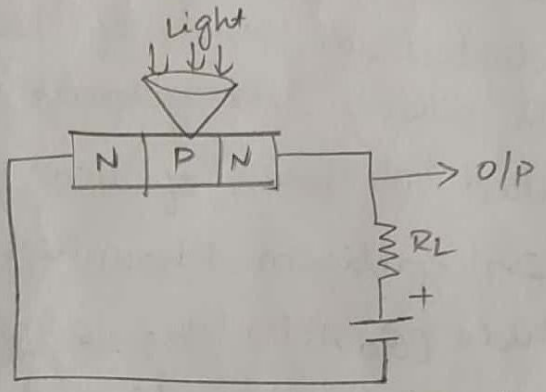


uses → light detectors
→ Demodulators and encoders.
→ optical communications and switching ckts.

Phototransistor :-

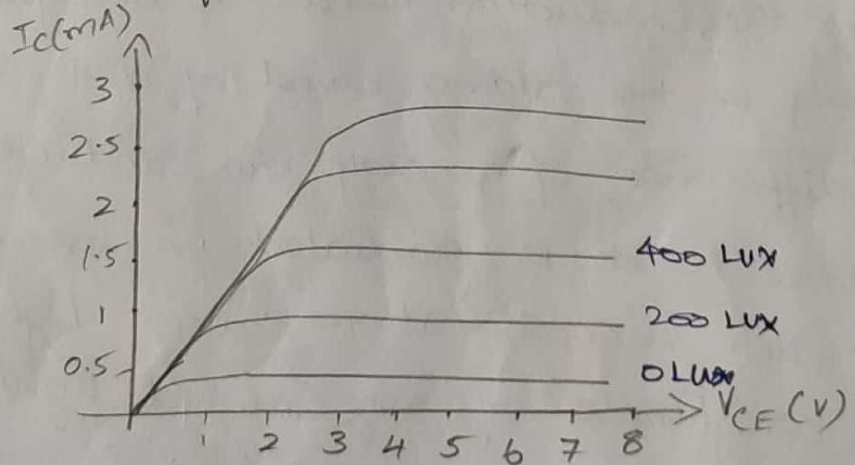
* The current produced by a photodiode is very low which cannot be directly used in control applications.
* Therefore this current should be amplified before applying to ctrl ckts.
* Photo transistor → photo diode + a transistor amplifier.
* When the phototransistor is illuminated, it permits a greater flow of current.





* A lens focusses the light on base - collector junction.
* Although the phototransistor has 3 sections, only 2 leads, emitter and collector leads are generally used.
* The phototransistor is dependent mainly on the intensity of light entering the lens and is less affected by the voltage applied to the external circuit.

Characteristics of phototransistor :-



Display Devices:-

i) Light Emiting Diode (LED):-

* LED → PN junction diode, which emits light when forward biased, → This phenomenon is called electroluminescence.

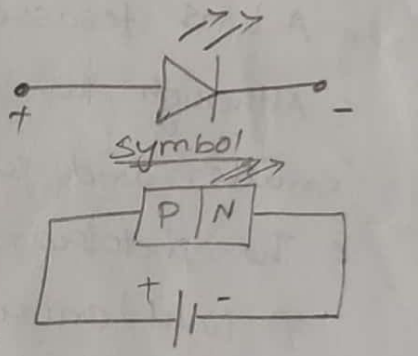
* In all semiconductor devices some amount of energy is radiated in form of heat

* In silicon and germanium, greater percentage of energy is emitted in form of heat.

* In gallium Phosphide (GaP) or gallium aerseride phosphide (GaAsP), the energy is radiated in form of light in visible spectrum.

Working:-

* When LED is forward biased, the electrons and holes move towards the junction and recombination takes place



Forward biased LED

* As a result of recombination, the electrons lying in the conduction bands of N-region fall into the holes lying in the valance band of a P-region.

* The difference of energy b/w conduction band and the valance band is radiated in form of light.

* Thus each recombination causes light emission.

* The brightness of the emitted light is directly proportional to the forward bias current.

Construction:-

* A N layer is grown on a substrate and P-type is deposited on it by diffusion.

* The carrier recombination takes place in P-layer and so it is kept uppermost.

* The metal anode connections are made at the outer edge of the P-layer it is kept ~~uppermost~~. so as to allow more central surface area for the light to escape.

* LED's are manufactured with domed lenses in order to reduce the reabsorption problem.

* A metal film is applied to the bottom of the substrate for reflecting as much light as possible.

* LED's are always encased to protect their delicate wires.

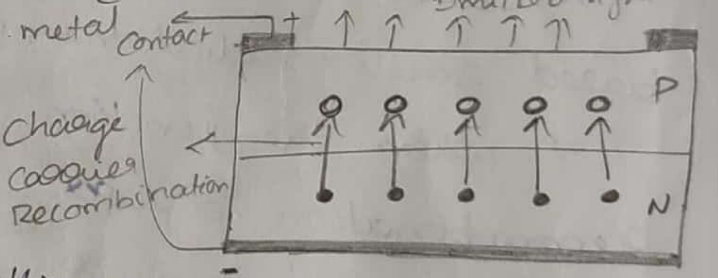
Colours of LED:-

Depending upon the material used, different colours of light are emitted.

i) Gallium arsenide (GaAs) - Infrared (Invisible)

ii) Gallium phosphide (GaP) - Red (or) Green.

iii) Gallium arsenide phosphide (GaAsP) - Red or yellow.



current & voltage req:-

operating voltage :-

1.5 to 3.3 V

current : Few tens of milliamps

Power : 10 to 150 mW.

Life time : 1,00,000 + hrs.

switch ON & off time of LED's : 1 ns. (so it is very fast)

To Protect LED it has to be connected along with a Resistor of 1 KΩ to 1.5 KΩ.

Applications:-

i) used in burglar alarm, Picture phones, multimeters, calculators, digital meters, microprocessors, digital computers, electronic telephone exchange, intercoms, ...

ii) Two-lead LED's are available, which contain 2 LED's which will change its colour from green to red when there is a reversal in biasing.

Injection Laser Diode (ILD):-

* when emitted light is coherent, then such a diode is referred to as ILD.

* ILD has less switch on time than LED.

* ∴ ILD are more suitable for wide-band and high data rate applications.

Disadvantage:- It has a strong temperature dependance.

Infra Red Emitters:-

* Gallium arsenide PN junction diodes, when forward biased emits radiations in Infra Red spectrum.

* when the junction is energised electron hole recombination occurs due to this recombination energy is emitted as infra red radiations.

* Infra red radiation wavelenght : 0.9 μm.

Applications:-

i) used in shaft encoders.

ii) Data-transmission systems.

iii) Intrusion alarm

iv) Card and paper tape readers.

Liquid Crystal Display (LCD):-

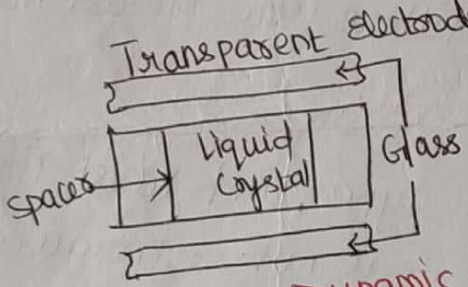
* used to display numeric & alphanumeric characters.
* 2 liquid crystal materials :- nematic (most common) NLC
  cholestoric

NLC:-

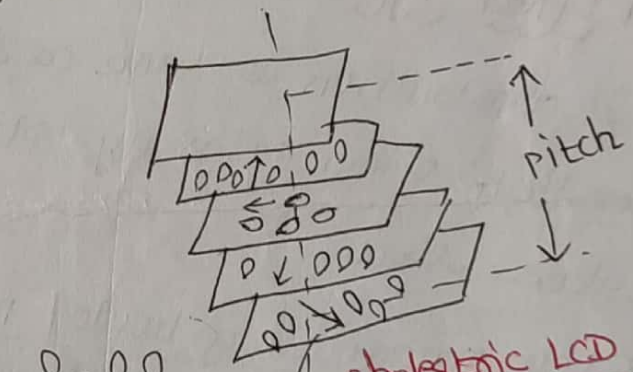
↳ All molecules align themselves approximately parallel to unique axis (director)

↳ liquid is normally transparent, but if it is subjected to strong electric disruption, the liquid may polarise & turn opaque.

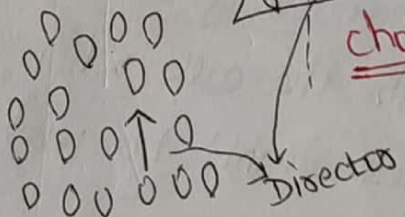
↳ Removal of applied electric field allows crystal to regain its original form & material becomes transparent.



Construction of Dynamic Scattering LCD



Cholestoric LCD



Nematic LCD

Construction of LCD:- Based on construction, there are 2 types of LCD.

(i) Dynamic Scattering Type:-

* Display has 2 glass plates coated with tin oxide (SnO_2) on inside with transparent electrodes.
* In b/w 2 glass plates, lies liquid crystal of 5 to 50 μm thick
* oxide coating is etched on front sheet to produce pattern of characters.

* weak electric field is applied to liquid crystal, which tends to align molecules in direction of field.

* when voltage exceeds, domain structure collapses, flow becomes turbulent & substance becomes inhomogeneous, & liquid crystal scatters light.

*when liquid is not activated, it is transparent. when liquid is activated with more electric field, light is scattered in all directions & cell appears bright. This is called as dynamic scattering.

(ii) Field Effect Type:-

* construction is same as dynamic scattering type, with exception that a thin polarising optical filters are placed inside each glass sheet.

* LCD material is of twisted nematic type, which twist the light passing through the cell. when latter is not energised.

* this allows light to pass through optical filters and cell appears bright.

Liquid crystal cell types

(i) Transmittive Type:-

Both glass sheets are transparent, so that light from real source is scattered in fwd direction when cell is activated

(ii) Reflective Type:-

It has reflective surface on one side of glass sheet. The incident light on front side of cell is dynamically scattered by an activated cell.

current & voltage levels:-

* LCD consume very small amount of energy.
* In 7-segment display, current drawn is 25μA for dynamic scattering cells & 300μA for field effect cells.
* LCD require a.c voltage supply.
* V/g level for scattering LCD's is 30V with 50Hz freq.

Advantages:-

* V/g required are small.
* Low power consumption.
* 7-segment display requires about 140W
  LED needs 40mW.
* Economical.

Disadvantages

* Very slow devices.
* ON & OFF times are quite large.
  ↓ few ms ↓ 10ms
* occupy large area.
* when used in d.c, life span is less.

X

Comparison b/w LED & LCD:-

LED	LCD
* Need more pwr (10-250mW) power/digit.	* Acts as capacitor & consumes less pwr. Needs 10-200μW.
* Due to high pwr requirement, it needs external circuitry to give pwr.	* pwr can be driven directly from IC chips.
* Good brightness level.	* Moderate brightness level.
* Temp range - 40 - 85°C.	* Temp range ⇒ -20 to 60°C
* Life time ⇒ 1,00,000 hrs	* Life time → 50,000 hrs
* Red, orange, yellow, green & white Colours	* Invisible in darkness.
* opr V/g - 1.5V to 5V dc	* opr V/g = 3 to 20 V a.c.
* Response time - 50 to 500 ns	* Response time - 50 to 200 ms
* Viewing angle - 150°.	* Viewing angle → 100°.

Optocouplers:-

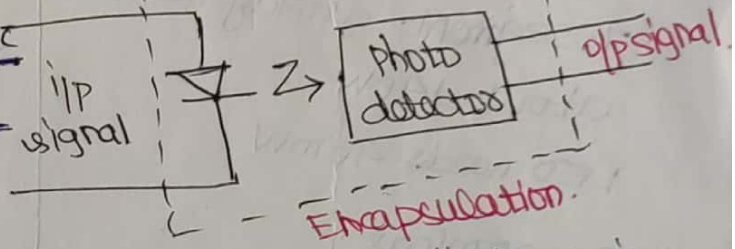
* solid state component which has light emitter, light path & light detector enclosed within & cannot be changed externally.

* As it provides electrical isolation → opto isolator

* Allows signal transfer without coupling wires, capacitors & transformers.

* couples digital (ON/OFF) or analog signals.

* Also called as optoelectronic isolator



↳ It has an infrared LED & photodetector like PIN photodiode, phototransistor Darlington pair

↳ optoisolators transduce i/p V/g to light using LED (GaAs).

↳ that light is transduced back to V/g using light sensitive devices.

↳ wavelength response of each device is made to be identical as possible.

↳ Transparent insulating cap b/w each material to permit passage of light. Very small response time & can txt in MHz range.

↳ Rigid structure allows one way transfer of electrical sgl from LED to photodetector.

Advantages

high isolation resistance of order of $10^{11}\Omega$ with isolation resistance of 2-500V.

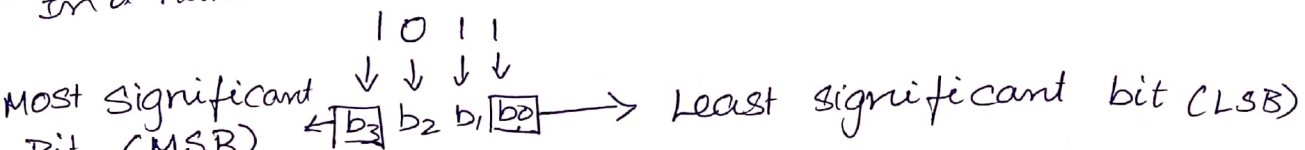
Unit - 5 Digital Systems.

Number systems:-

Different number systems.

	system	numbers	Base	example.
i)	Binary	(0, 1)	2	$(11011)_2$
ii)	octal	(0, 1 ... 7	8	$(3567)_8$
iii)	Decimal	(0, 1 9	10	$(3926)_{10}$
iv)	Hexadecimal	0, 1, 2 ... 9, A, B, ... F	16	$(37A5D)_{16}$.

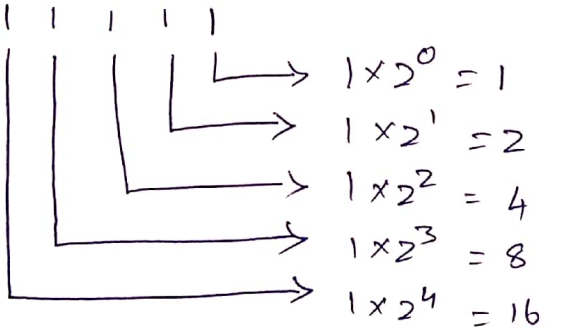
Note:-
In a number



Conversion of number systems.

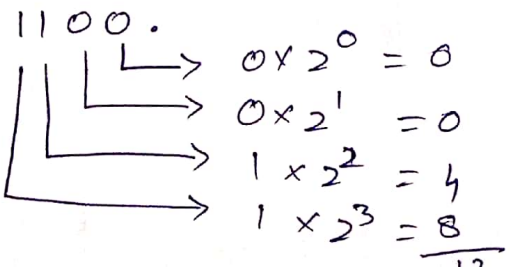
i) Binary to Decimal.

(a) $(11111)_2$ into decimal



$(11111)_2 = (31)_{10}$.

(b) 1100.1011 into decimal.



(start to no. from decimal)

1100.1011
3 2 1 0 . -1 -2 -3 -4

$= (1 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (0 \times 2^0) + (1 \times 2^{-1}) + (0 \times 2^{-2}) + (1 \times 2^{-3}) + (1 \times 2^{-4})$

$= 8 + 4 + \frac{1}{2} + \frac{1}{8} + \frac{1}{16}$

$= 12.6875$

$(1100.1011)_2 = (12.6875)_{10}$.

Binary	octal
000	0
001	1
010	2
011	3
100	4
101	5
110	6
111	7

ii) Binary to octal :-

a) $(1100.01)_2$ to octal.

001 | 100 . | 010 => 14.2

* split the given value as 3 digits and add zeros at end if needed.
* In case of decimal no. start spliting from decimal value

$\therefore (1100.01)_2 = (14.2)_8$.

iii) Binary to Hexadecimal.

a) 11101101.101101

* split the given value as 4 digits and add zeros at the end if needed.
* In case of decimal no. start spliting from decimal value.

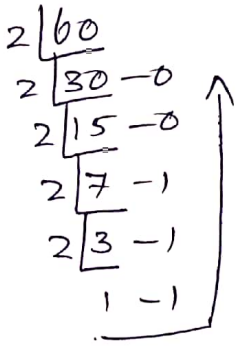
1110	1101 .	1011	0100
↓	↓	↓	↓ added zero.
E	D .	B	4

$(11101101.101101)_2 = (ED.B4)_{16}$

Binary	Hexadecimal
0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	A
1011	B
1100	C
1101	D
1110	E
1111	F

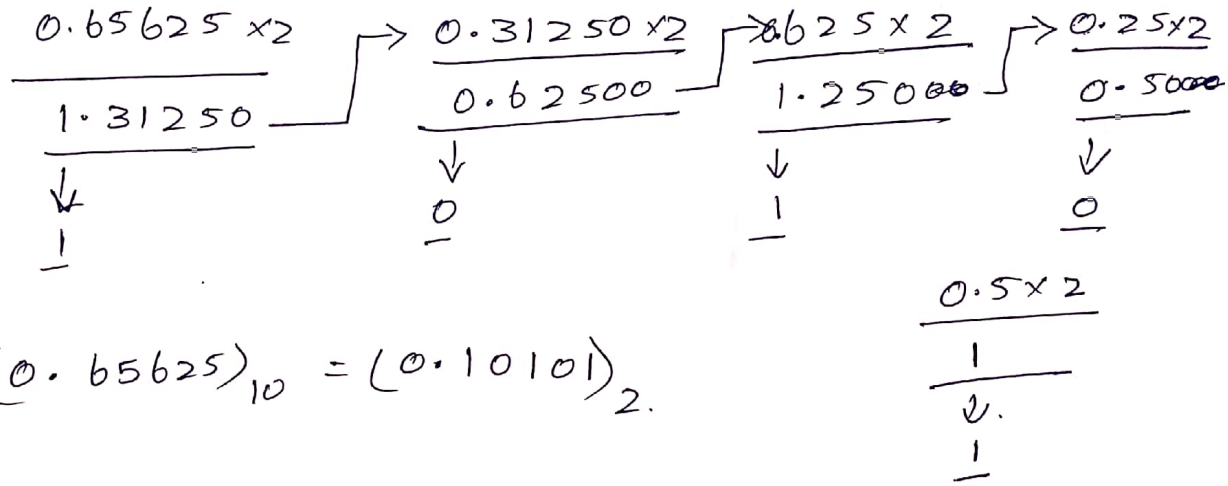
iv) Decimal to Binary:

a) $(60)_{10}$ into binary.



$\therefore (60)_{10} = (11100)_2$

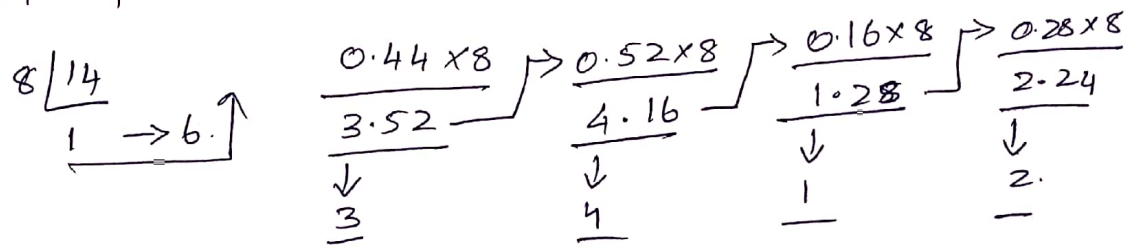
b) $(0.65625)_{10}$ into binary.



$(0.65625)_{10} = (0.10101)_2$.

v) Decimal to octal:

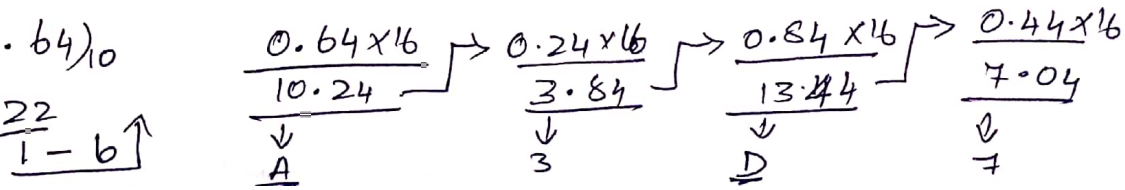
14.44



$\therefore (14.44)_{10} = (16.3412)_8$,

vi) Decimal to Hexa decimal.

$(22.64)_{10}$



$(22.64)_{10} = (16.A3D7)_{16}$.

vii) Octal to Binary:-

(a) $(36.5)_8$ to Binary:-

3 → 011, 6 → 110, . , 5 → 101

$(36.5)_8 = (11110.101)_2$.

viii) Octal to Decimal and octal to Hexadecimal.

Note:- First convert octal into Binary then convert that Binary value to octal (or) Hexadecimal as needed.

ix) Hexadecimal to Binary:-

$(A65D.EF)_{16}$

A → 1010, 6 → 0110, 5 → 0101, D → 1101, . , E → 1110, F → 1111

$(A65D.EF)_{16} = (1010\,0110\,0101\,1101.1110\,1111)_2$.

x) Hexadecimal to Decimal and Hexadecimal to octal.

Note:- First convert Hexadecimal no. to Binary then convert that Binary value into Decimal or Hexadecimal as required.

ONE's complement (1's complement)

or 1's complement is complement of each digit in the given no.

ex 1101 → 1's complement is $(0010)_2$

1 1 0 1 → 0 0 1 0 → complement of each digit.

2's complement :-

Adding '1' to 1's complement gives 2's complement

eg: 11011

↳ 1's complement 00100

\+ 1

00101

↓

2's complement.

Binary arithmetic

i) Addition of Binary no's.

a) Add $(11011)_2$ and $(110111)_2$

```
  1 1 1 1 1
  1 1 0 1 1
+ 1 1 0 1 1 1
-------------
(1 0 1 0 0 1 0)2
```

0+0 → 0
0+1 → 1
1+0 → 1
1+1 → 10

b) Add $(11.11)_2$ and $(10.11)_2$

```
  1 1 1
  1 1 . 1 1
+ 1 0 . 1 1
-----------
(1 1 0 . 1 0)2
```

ii) Subtraction of Binary no's

a) $(11000)_2 - (111)_2$

```
  0 1 1 1 10
  1 1 Ø Ø Ø
-     1 1 1
-------------
(1 0 0 0 1)2.
```

0 - 0 → 0
10 - 1 → 1
1 - 0 → 0
1 - 1 → 1

Note: If the above method is difficult then follow complement method for subtraction.

Complement method.

Minuend
- subtrahend

Rules :-

i) Find 2's complement of the subtrahend

ii) Add the minuend and 2's complement of subtrahend

iii) The Result will always end up with '1', omit the '1' at MSB and the Rest will be your answer.

or

$(11000)_2 - (01111)_2$

i) Step 1 :- 2's complement of 10111

111 → 1's complement 01000

\+ 1

2's complement → 1001

ii) Step 2 :-

```
  1
 11000
(+)01001
 10001
```

MSB 1 ← omit it

$(10001)_2$ is the answer.

(iii) Multiplication :-

```
  101 x 101
 -----------
  101
 000x
101xx
-------
(11001)2.
```

Boolean Theorems:

Identity:-	$A + 0 = A$	$A \cdot 1 = A$
	$A + 1 = 1$	$A \cdot 0 = 0$.
Complement:-	$A + \bar{A} = 1$	$A \cdot \bar{A} = 0$
Idempotency:-	$A + A = A$	$A \cdot A = A$
Involution:	$\overline{\bar{A}} = A$.	
Absorption:	$A + AB = A$	$A(A+B) = A$.
	$A + \bar{A}B = A+B$	$A \cdot (\bar{A} + B) = AB$.
Duality:	$A + \bar{A} = 1$	$A \cdot \bar{A} = 0$
Commutative:	$A + B = B + A$	$AB = B \cdot A$
Distributive:	$A(B+C) = AB + AC$	$A + BC = (A+B)(A+C)$
Associative:	$A+(B+C) = (A+B)+C$	$A(BC) = (AB)C$.
De morgan's Law:	$\overline{A+B} = \bar{A} \cdot \bar{B}$	$\overline{AB} = \bar{A} + \bar{B}$.

Simplification of Boolean expressions:-

Examples

i) simplify $x + \bar{x}y$.

$Z = x + \bar{x}y = x + y$ ($\because$ by absorption law)

ii) simplify $\overline{A + B\bar{C}}$

$\overline{A + B\bar{C}} = \bar{A} \cdot \overline{B\bar{C}}$

$= \bar{A} \cdot (\bar{B} + \bar{\bar{C}})$

$= \bar{A} \cdot (\bar{B} + C) = \bar{A}\bar{B} + \bar{A}C$.

3) simplify:- $(x_1 + x_2)(\bar{x}_1 \bar{x}_3 + x_3)(\overline{\bar{x}_2 + x_1 x_3}) = \bar{x}_1 x_2$

Prove:-

$$(x_1 + x_2)(\bar{x}_1 \bar{x}_3 + x_3)(\overline{\bar{x}_2 + x_1 x_3}) =$$

$$= (x_1 + x_2)(\bar{x}_1 \bar{x}_3 + x_3)(\bar{\bar{x}}_2 \cdot \overline{(x_1 x_3)})$$

$$= (x_1 + x_2)(\bar{x}_1 \bar{x}_3 + x_3)(x_2 (\bar{x}_1 + \bar{x}_3))$$

$$= (x_1 + x_2)(\bar{x}_1 \bar{x}_3 + x_3)(x_2 \bar{x}_1 + x_2 \bar{x}_3)$$

$$= (x_1 + x_2)(\bar{x}_1 + x_3)(x_2 \bar{x}_1 + x_2 \bar{x}_3) \quad (\because \text{Absorption Law})$$

$$= (x_1 \bar{x}_1^{\,0} + \bar{x}_1 x_2 + x_1 x_3 + x_2 x_3)(x_2 \bar{x}_1 + x_2 \bar{x}_3)$$

$$= (\bar{x}_1 x_2 + x_1 x_3 + x_2 x_3)(x_2 \bar{x}_1 + x_2 \bar{x}_3)$$

$$= \bar{x}_1 x_2 x_2 \bar{x}_1 + x_2 \bar{x}_1 x_1^{\,0} x_3 + x_2 \bar{x}_1 x_2 x_3 + x_2 \bar{x}_3 \bar{x}_1 x_2 + x_1 x_3 x_2^{\,0} \bar{x}_3 + x_2 x_3 x_2^{\,0} \bar{x}_3$$

$$= \bar{x}_1 x_2 + \bar{x}_1 x_2 x_3 + \bar{x}_1 x_2 \bar{x}_3$$

$$= \bar{x}_1 \cdot x_2 (1 + x_3 + \bar{x}_3)$$

$$= \bar{x}_1 x_2 \quad (\because A + \bar{A} = 1,\ 1 + 1 = 1)$$

Hence proved.

4) Logic function $f = \overline{(x \cdot \bar{y}) + (\bar{x} \cdot y)}$ is the same as [Gate 2016]

a) $f = (x + y)(\bar{x} + y)$ b) $f = \bar{x}\bar{y} + xy$

c) $f = \overline{(x \cdot y)} \cdot (\bar{x} \cdot \bar{y})$ d) None of these.

$$\overline{(x \cdot \bar{y}) + (\bar{x} \cdot y)} = \overline{(x \cdot \bar{y})} \cdot \overline{(\bar{x} \cdot y)}$$

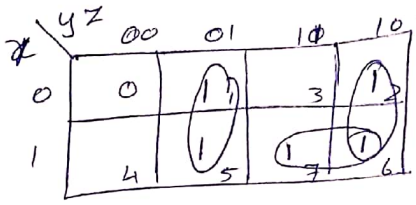
$$= (\bar{x} + \bar{\bar{y}})(\bar{\bar{x}} + \bar{y})$$

$$= (\bar{x} + y)(x + y)$$

5) Boolean expression $\bar{x}y\bar{z} + \bar{x}\bar{y}z + xy\bar{z} + x\bar{y}z + xyz$ can be simplified to. [Gate 2014]

$\underset{010}{\bar{x}y\bar{z}} + \underset{001}{\bar{x}\bar{y}z} + \underset{110}{xy\bar{z}} + \underset{101}{x\bar{y}z} + \underset{111}{xyz}.$

2 1 6 5 7.



$F = \bar{y}z + y\bar{z} + xy.$

(or)

$F = \bar{y}z + y\bar{z} + xz.$

6) The Boolean expression $F(x, y, z) = \bar{x}y\bar{z} + x\bar{y}\bar{z} + xy\bar{z} + xyz$ converted into the canonical product of sum (POS) form is.

$F = \underset{010}{x\bar{y}\bar{z}} + \underset{100}{x\bar{y}\bar{z}} + \underset{110}{xy\bar{z}} + \underset{111}{xyz}.$

$F = (x + \bar{y} + z)(\bar{x} + y + z)(\bar{x} + \bar{y} + z)(\bar{x} + \bar{y} + \bar{z}).$

7) The Boolean expression $(x + y)(x + \bar{y}) + (\overline{x\bar{y} + \bar{x}})$ simplifies to _____ [Gate 2014]

$F = (x+y)(x+\bar{y}) + (\overline{x\bar{y}} \cdot \overline{\bar{x}})$

$= (x+y)(x+\bar{y}) + (\bar{x} + y)x.$

$= xx + xy + x\bar{y} + y\bar{y} + \bar{x}x + xy.$ ($y\bar{y} \to 0$, $\bar{x}x \to 0$)

$= x + xy + x\bar{y}$

$= x + x(y + \bar{y})$

$= x + x$

$= x$

8) Simplify:

a) $\bar{x}\bar{y}z + \overline{(\bar{x}\bar{y}z)}$

$= \bar{x}\bar{y}z + (\bar{\bar{x}} + \bar{\bar{y}} + \bar{\bar{z}})$

$= \bar{x}\bar{y}z + (x + y + z)$

~~$x\bar{x}\bar{y}z + y\bar{x}\bar{y}z + \bar{x}\bar{y}z\bar{z}$~~

$= \bar{x}\bar{y}z + x + y + \bar{z}$,,

SOP and POS Forms:-

SOP → sum of products.

eg:- $y = xyz + x\bar{y}z + xy\bar{z} + \bar{x}yz$.
↳ minterms.

POS → Product of sum.

eg:- $y = (\bar{x}+y+z)(\bar{x}+y+\bar{z})(\bar{x}+\bar{y}+z)(x+\bar{y}+\bar{z})$
↳ Maxterms.

Simplification of Boolean expression using K-map:-

Two variable K-map

A \ B	0	1
0	0	1
1	2	3

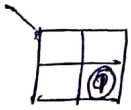
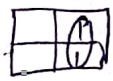
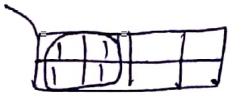
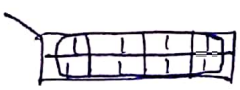
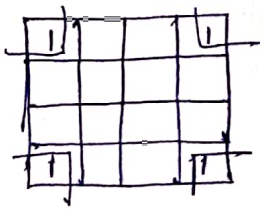
3-variable K-map

	00	01	11	10
0	0	1	3	2
1	4	5	7	6

4-variable K-map.

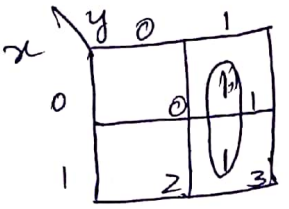
	00	01	11	10
00	0	1	3	2
01	4	5	7	6
11	12	13	15	14
10	8	9	11	10

Grouping Rules.

* single grouping 
* Double grouping 
* 4 - grouping 
* 8 - grouping 
* corner - grouping 

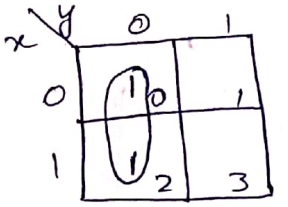
2 - Variable K - Map :-

1) $F(x, y) = \Sigma m(1, 3)$



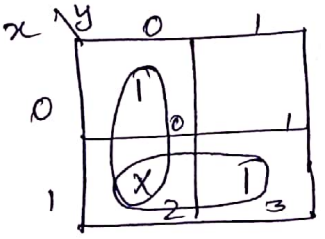
$F = y$

ii) $F(x, y) = \Sigma m(0, 2)$ → summation of minterms → SOP form



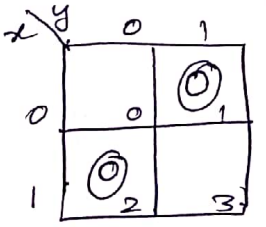
$F = \bar{y}$

iii) $F(x, y) = \Sigma m(0, 3) + \Sigma d(2)$



$F = \bar{y} + x$

iv) $F(x, y) = \Pi M(1, 2)$ → Product of Maxterms → Pos form

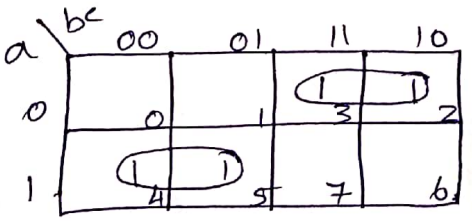


~~$F = (\bar{x}+y)\cdot(x+\bar{y})$~~

$F = (x+\bar{y})(\bar{x}+y)$.

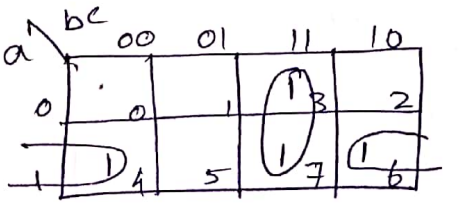
3 - Variable K - map :-

i) $F(a, b, c) = \Sigma m(2, 3, 4, 5)$



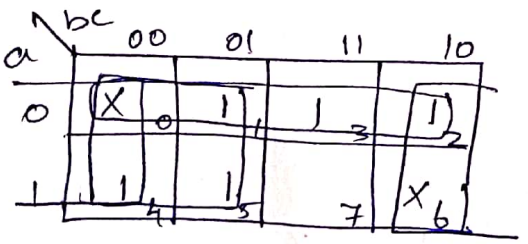
$F = \bar{a}\bar{b} + \bar{a}b$

ii) $F(a, b, c) = \Sigma m(3, 4, 6, 7)$



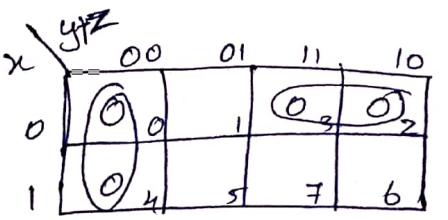
$F = bc + a\bar{c}$.

iii) $F(a, b, c) = \Sigma m(1, 2, 3, 4, 5) + \Sigma d(0, 6)$



$F = \bar{a} + \bar{b} + \bar{c}$

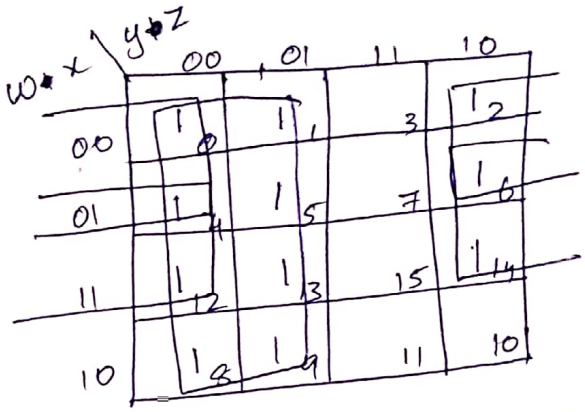
(iv) $F(x, y, z) = \Pi M(0, 2, 3, 4)$



$F = (y+z)(x+\bar{y})$

4 - Variable K - Map:-

i) $F(w, x, y, z) = \Sigma m(0, 1, 2, 4, 5, 6, 8, 9, 12, 13, 14)$

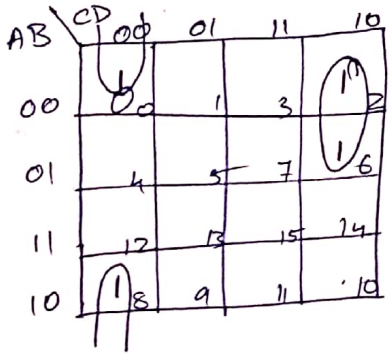


$F = \bar{y} + \bar{w}\bar{z} + x\bar{z}$.

ii) $F = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{B}C\bar{D} + A\bar{B}C\bar{D} + A\bar{B}\bar{C}\bar{D}$. simplify it.

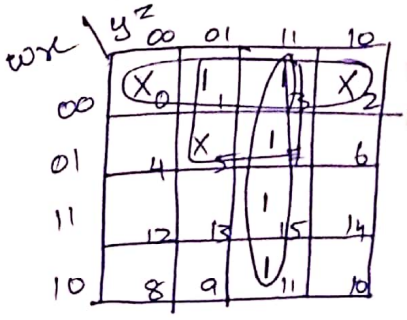
$0000 \quad 0010 \quad 0110 \quad 1000$

$0 \quad 2 \quad 6 \quad 8$



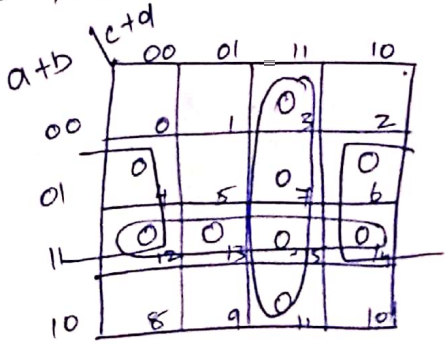
$F = \bar{B}\bar{C}\bar{D} + \bar{A}C\bar{D}$.

iii) $F(w, x, y, z) = \Sigma m(1, 3, 7, 11, 15) + \Sigma d(0, 2, 5)$



$F = \bar{w}x + yz + \bar{w}z$.

iv) $F(a, b, c, d) = \pi M(0, 1, 2, 5, 8, 9, 10)$



$F = (\bar{a} + \bar{b})(\bar{c} + \bar{d})(\bar{b} + d)$

Communication System:-

The basic elements of a communication system are i) Information (or) i/p signal

ii) Input transducer

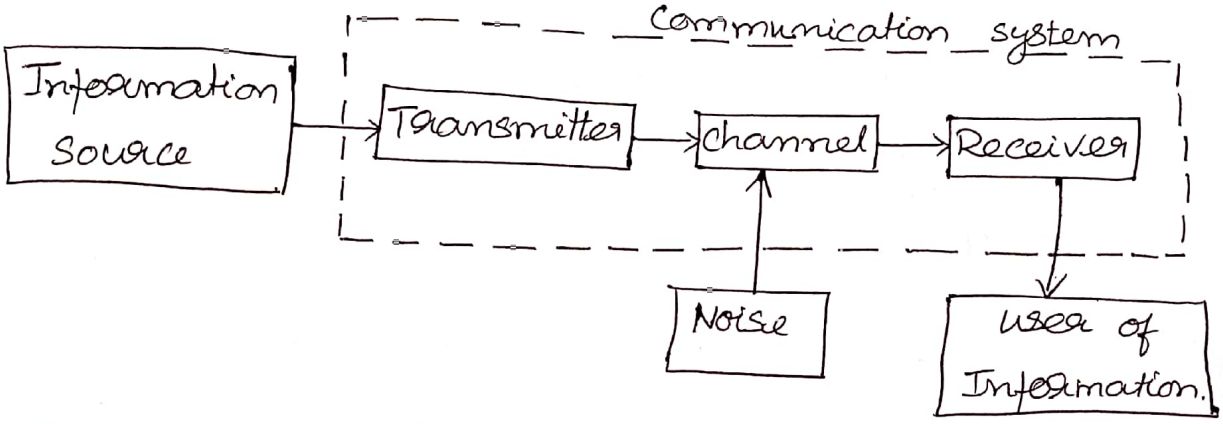
iii) Transmitter

iv) Communication channel or medium

v) Noise

vi) Receiver

vii) output transducer.



i) Information or i/p signal:-

* The communication systems have been developed for communicating useful information from one place to other

* The information can be in the form of sound like speech or music or it can be in the form of pictures.

ii) Input Transducer:-

* The information in the form of sound, picture or data signals cannot be transmitted as it is.

* First it has to be converted into a suitable electrical signal

* The input transducers commonly used in the comm-unication systems are microphones, TV etc...

3) Transmitter:-

* The function of the transmitter block is to convert the electrical equivalent of the information to a suitable form

* It increases the power level of the signal. The Power level should be increased in order to cover a large range. The transmitter consist of the electronics circuits such as amplifier, mixer, oscillator, and power amplifier.

4) Communication channel or Medium:

* The communication channel is the medium used for the transmission of electronic signals from one place to the another.

* The communication medium can be conducting wires, cables, optical fibres or free space. Depending upon the type of the communication ~~system~~ medium, two types of the communication system will exist

a) Wire communication (or) line communication

b) Wireless " (or) radio "

5) Noise:-

* Noise is an unwanted electrical signal which gets added to the transmitted signal when it is travelling towards receiver.

* Due to noise, the quality of the transmitted information will degrade. once added the noise cannot be seperated out from the information.

* Hence noise is a big problem in the communication system.

6) Receiver:-

* The reception of signal is sensed by the Receiver unit.

* The reception is exactly the opposite process of transmission. The received signal is amplified and demodulated and converted in a suitable form.

* The receiver consist of the electronic circuits like mixer, oscillator, detector and amplifier.

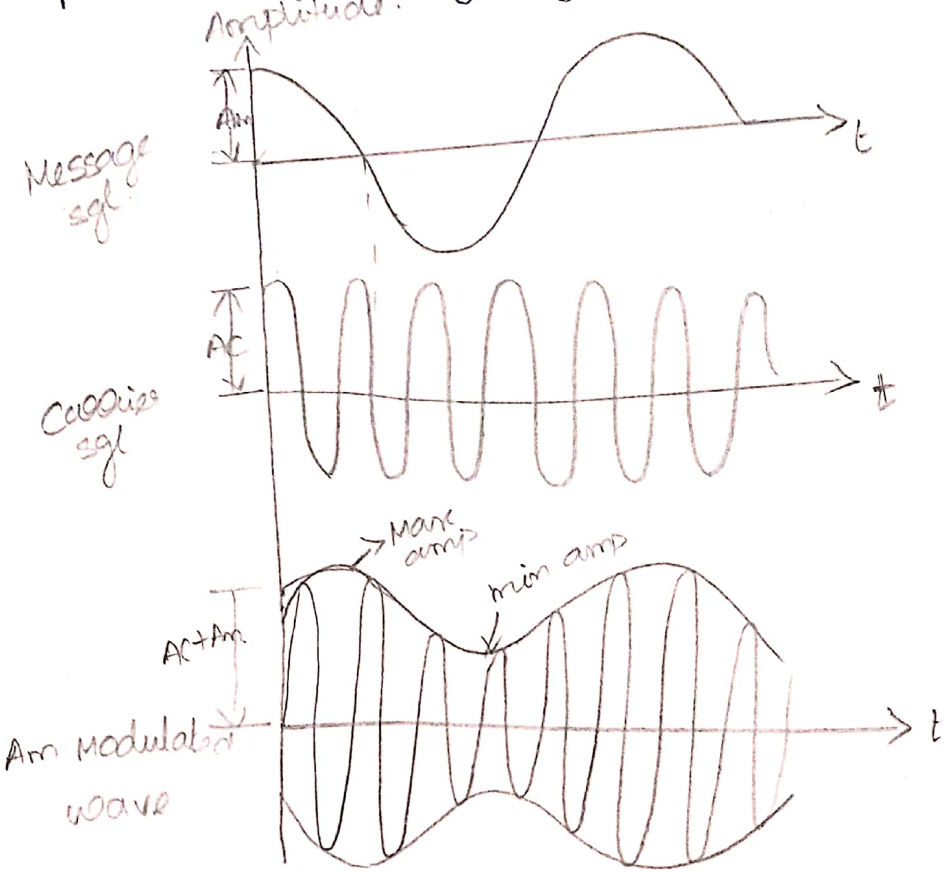
7) output Transducer:-

* It consist of the electrical signal at the output of the receiver back to the original form. ie., sound or TV picture

* The typical example of the output transducers are load speakers, picture tube etc...

Amplitude Modulation:-

The amplitude of the carrier signal varies in accordance with the instantaneous amplitude of the modulating signal.



Let the modulating signal be,

$$m(t) = A_m \cos(2\pi f_m t)$$

The carrier signal be.

$$c(t) = A_c \cos(2\pi f_c t)$$

A_m → Amplitude of message sgl.

A_c → " " carrier "

f_m → frequency " message "

f_c → " " carrier "

The equation of amplitude modulated wave will be

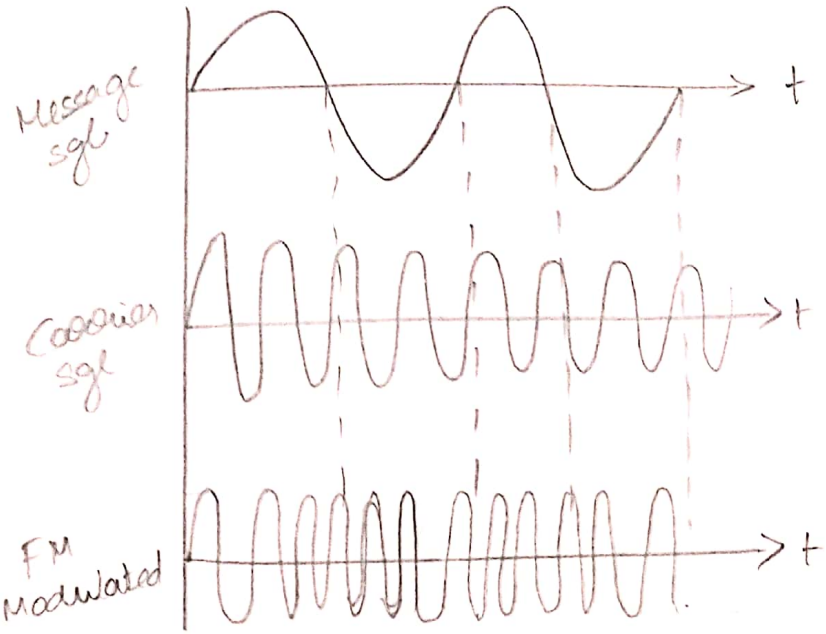
$$S(t) = [A_c + A_m \cos(2\pi f_m t)] \cos(2\pi f_c t).$$

Modulation Index

$$K = \frac{A_m}{A_c}$$

Frequency Modulation:.

The frequency of the carrier signal is varied in accordance with the instantaneous amplitude of the message signal.



$$v_c(t) = A_c \cos(\omega_c t)$$

$$m(t) = A_m \cos(\omega_m t)$$

$$V_{fm}(t) = V_c \cos(2\pi (f_c + \text{freq deviation}) t)$$

freq deviation depends on $m(t)$.

A GEOPHONE IS A DEVICE THAT CONVERTS GROUND MOVEMENT (VELOCITY) INTO VOLTAGE, WHICH MAY BE RECORDED AT A RECORDING STATION. THE DEVIATION OF THIS MEASURED VOLTAGE FROM THE BASE LINE IS CALLED **THE SEISMIC RESPONSE** AND IS ANALYZED FOR STRUCTURE OF THE EARTH.CONSTRUCTION

GEOSOURCE INC. MD-79—8HZ, 335Ω GEOPHONE
GEOPHONES HAVE HISTORICALLY BEEN PASSIVE ANALOG DEVICES AND TYPICALLY COMPRISE A SPRING-MOUNTED WIRE COIL MOVING WITHIN THE FIELD OF A CASE-MOUNTED PERMANENT MAGNET TO GENERATE AN ELECTRICAL SIGNAL.[1] RECENT DESIGNS HAVE BEEN BASED ON MICROELECTROMECHANICAL SYSTEMS (MEMS) TECHNOLOGY WHICH GENERATES AN ELECTRICAL RESPONSE TO GROUND MOTION THROUGH AN ACTIVE FEEDBACK CIRCUIT TO MAINTAIN THE POSITION OF A SMALL PIECE OF SILICON.

THE RESPONSE OF A COIL/MAGNET GEOPHONE IS PROPORTIONAL TO GROUND VELOCITY, WHILE MEMS DEVICES USUALLY RESPOND PROPORTIONAL TO ACCELERATION. MEMS HAVE A MUCH HIGHER NOISE LEVEL (50 DB VELOCITY HIGHER) THAN GEOPHONES AND CAN ONLY BE USED IN STRONG MOTION OR ACTIVE SEISMIC APPLICATIONS.

A HYDROPHONE IS A MICROPHONE DESIGNED TO BE USED UNDERWATER FOR RECORDING OR LISTENING TO UNDERWATER SOUND. MOST HYDROPHONES ARE BASED ON A PIEZOELECTRIC TRANSDUCER THAT GENERATES AN ELECTRIC POTENTIAL WHEN SUBJECTED TO A PRESSURE CHANGE, SUCH AS A SOUND WAVE. SOME PIEZOELECTRIC TRANSDUCERS CAN ALSO SERVE AS A SOUND PROJECTOR, BUT NOT ALL HAVE THIS CAPABILITY, AND SOME MAY BE DESTROYED IF USED IN SUCH A MANNER.

A HYDROPHONE CAN DETECT AIRBORNE SOUNDS, BUT WILL BE INSENSITIVE BECAUSE IT IS DESIGNED TO MATCH THE ACOUSTIC IMPEDANCE OF WATER, A DENSER FLUID THAN AIR. SOUND TRAVELS 4.3 TIMES FASTER IN WATER THAN IN AIR, AND A SOUND WAVE IN WATER EXERTS A PRESSURE 60 TIMES THAT EXERTED BY A WAVE OF THE SAME AMPLITUDE IN AIR. SIMILARLY, A STANDARD MICROPHONE CAN BE BURIED IN THE GROUND, OR IMMERSED IN WATER IF IT IS PUT IN A WATERPROOF CONTAINER, BUT WILL GIVE POOR PERFORMANCE DUE TO THE SIMILARLY BAD ACOUSTIC IMPEDANCE MATCH.

A TACTILE TRANSDUCER OR "BASS SHAKER" IS A DEVICE WHICH IS MADE ON THE PRINCIPLE THAT LOW BASS FREQUENCIES CAN BE FELT AS WELL AS HEARD. THEY CAN BE COMPARED WITH A COMMON LOUDSPEAKER, JUST THAT THE DIAPHRAGM IS MISSING. INSTEAD, ANOTHER OBJECT IS USED AS A DIAPHRAGM. A SHAKER TRANSMITS LOW-FREQUENCY VIBRATIONS INTO VARIOUS SURFACES SO THAT THEY CAN BE FELT BY PEOPLE. THIS IS CALLED TACTILE SOUND. TACTILE TRANSDUCERS MAY AUGMENT OR IN SOME CASES SUBSTITUTE FOR A SUBWOOFER. ONE BENEFIT OF TACTILE TRANSDUCERS IS THEY PRODUCE LITTLE OR NO NOISE, IF PROPERLY INSTALLED, AS COMPARED WITH A SUBWOOFER SPEAKER ENCLOSURE.

A MAGNETIC CARTRIDGE, MORE COMMONLY CALLED A PHONOGRAPH CARTRIDGE OR PHONO CARTRIDGE OR (COLLOQUIALLY) A PICKUP, IS AN ELECTROMECHANICAL TRANSDUCER THAT IS USED TO PLAY RECORDS ON A TURNTABLE.

A MICROPHONE, COLLOQUIALLY CALLED A MIC OR MIKE (/MA[?]K/),[1] IS A DEVICE – A TRANSDUCER – THAT CONVERTS SOUND INTO AN ELECTRICAL SIGNAL. MICROPHONES ARE USED IN MANY APPLICATIONS SUCH AS TELEPHONES, HEARING AIDS, PUBLIC ADDRESS SYSTEMS FOR CONCERT HALLS AND PUBLIC EVENTS, MOTION PICTURE PRODUCTION, LIVE AND RECORDED AUDIO ENGINEERING, SOUND RECORDING, TWO-WAY RADIOS, MEGAPHONES, RADIO AND TELEVISION BROADCASTING. THEY ARE ALSO USED IN COMPUTERS FOR RECORDING

VOICE, SPEECH RECOGNITION, VOIP, AND FOR NON-ACOUSTIC PURPOSES SUCH AS ULTRASONIC SENSORS OR KNOCK SENSORS.

HOW DOES A MICROPHONE TURN SOUND ENERGY INTO ELECTRICAL ENERGY?

WHEN YOU SPEAK, SOUND WAVES CREATED BY YOUR VOICE CARRY ENERGY TOWARD THE MICROPHONE. REMEMBER THAT SOUND WE CAN HEAR IS ENERGY CARRIED BY VIBRATIONS IN THE AIR.

INSIDE THE MICROPHONE, THE DIAPHRAGM (MUCH SMALLER THAN YOU'D FIND IN A LOUDSPEAKER AND USUALLY MADE OF VERY THIN PLASTIC) MOVES BACK AND FORTH WHEN THE SOUND WAVES HIT IT.
THE COIL, ATTACHED TO THE DIAPHRAGM, MOVES BACK AND FORTH AS WELL.
THE PERMANENT MAGNET PRODUCES A MAGNETIC FIELD THAT CUTS THROUGH THE COIL. AS THE COIL MOVES BACK AND FORTH THROUGH THE MAGNETIC FIELD, AN ELECTRIC CURRENT FLOWS THROUGH IT.

THE ELECTRIC CURRENT FLOWS OUT FROM THE MICROPHONE TO AN AMPLIFIER OR SOUND RECORDING DEVICE. HEY PRESTO, YOU'VE CONVERTED YOUR ORIGINAL SOUND INTO ELECTRICITY! BY USING THIS CURRENT TO DRIVE SOUND RECORDING EQUIPMENT, YOU CAN EFFECTIVELY STORE THE SOUND FOREVER MORE. OR YOU COULD AMPLIFY (BOOST THE SIZE OF) THE CURRENT AND THEN FEED IT INTO A LOUDSPEAKER, TURNING THE ELECTRICITY BACK INTO MUCH LOUDER SOUND. THAT'S HOW PA (PERSONAL ADDRESS) SYSTEMS, ELECTRIC GUITAR AMPLIFIERS, AND ROCK CONCERT AMPLIFIERS WORK.

HOW DO SPEAKERS WORK?
SPEAKERS WORK BY CONVERTING ELECTRICAL ENERGY INTO MECHANICAL ENERGY (MOTION). THE MECHANICAL ENERGY COMPRESSES AIR AND CONVERTS THE MOTION INTO SOUND ENERGY OR SOUND PRESSURE LEVEL (SPL).

WHEN AN ELECTRIC CURRENT IS SENT THROUGH A COIL OF WIRE, IT INDUCES A MAGNETIC FIELD.

THE FULL FORM OF SONAR IS SOUND NAVIGATION AND RANGING. THE SONAR METHOD IS ALSO CALLED **ECHO RANGING.** IT IS A DEVICE THAT UTILIZES ULTRASONIC WAVES TO ESTIMATE AND MEASURE THE DISTANCE, DIRECTION AND SPEED OF OBJECTS UNDERWATER.PRINCIPLE OF SONAR:IT USES ECHOES IN TO DETERMINE THE SEA-DEPTH AND LOCATING THE PRESENCE OF OBJECTS UNDERWATER..WORKING OF SONAR:
IT CONSISTS OF A TRANSMITTER AND A DETECTOR AND IS INSTALLED IN A SHIP OR A BOAT.
THE TRANSMITTER IN SONAR PRODUCES AND TRANSMITS POWERFUL ULTRASONIC WAVES.
THE ULTRASONIC WAVES TRAVEL THROUGH THE WATER AND AFTER STRIKING THE TARGET THE BEAM IS REFLECTED FROM THE SEABED AND IS RECEIVED BY AN UNDER-WATER DETECTOR (MOUNTED ON THE SHIP).
THE DETECTOR THEN CONVERTS THE WAVES INTO ELECTRICAL SIGNALS WHICH ARE PROPERLY INTERPRETED.
THE TIME INTERVAL BETWEEN TRANSMISSION AND RECEPTION OF THE SIGNAL IS ALSO NOTED.

WHAT IS AN ULTRASONIC TRANSDUCER?

THE ULTRASONIC TRANSDUCER IS ONE TYPE OF SOUND-RELATED SENSOR. THESE TRANSDUCERS SEND THE ELECTRICAL SIGNALS TO THE OBJECT AND ONCE THE SIGNAL STRIKES THE OBJECT THEN IT REVERTS TO THE TRANSDUCER. IN THIS PROCESS, THIS TRANSDUCER MEASURES THE DISTANCE OF THE OBJECT NOT BY THE INTENSITY OF THE SOUND.

THESE TRANSDUCERS USE ULTRASONIC WAVES FOR THE MEASUREMENT OF A FEW PARAMETERS. IT HAS A WIDE RANGE OF APPLICATIONS IN VARIOUS FIELDS. THE FREQUENCY RANGE OF ULTRASONIC WAVES IS ABOVE 20 KHZ. THESE ARE MAINLY USED IN MEASURING DISTANCE APPLICATIONS. THE FOLLOWING IMAGE INDICATES THE ULTRASONIC TRANSDUCER.

ULTRASONIC TRANSDUCER WORKING PRINCIPLE

WHEN AN ELECTRICAL SIGNAL IS APPLIED TO THIS TRANSDUCER, IT VIBRATES AROUND THE SPECIFIC FREQUENCY RANGE AND GENERATES A SOUND WAVE. THESE SOUND WAVES TRAVEL AND WHENEVER ANY OBSTACLE COMES, THESE SOUND WAVES WILL REFLECT THE TRANSDUCER INFORM OF ECHO. AND AT THE END OF THE TRANSDUCER, THIS ECHO CONVERTS INTO AN ELECTRICAL SIGNAL.

HERE, THE TRANSDUCER CALCULATES THE TIME INTERVAL BETWEEN THE SENDING OF THE SOUND WAVE TO THE RECEIVING THE ECHO SIGNAL. THE ULTRASONIC SENSOR SENDS THE ULTRASONIC PULSE AT 40 KHZ WHICH TRAVELS THROUGH THE AIR. THESE TRANSDUCERS ARE BETTER THAN THE INFRARED SENSORS BECAUSE THESE ULTRASONIC TRANSDUCER/SENSORS ARE NOT AFFECTED BY THE SMOKE, BLACK MATERIALS, ETC. ULTRASONIC SENSORS EXHIBIT EXCELLENCE IN SUPPRESSING BACKGROUND INTERFERENCE.

HOW DOES AN ANTENNA WORK?

THE ANTENNA AT THE TRANSMITTER GENERATES THE RADIO WAVE. A VOLTAGE AT THE DESIRED FREQUENCY IS APPLIED TO THE ANTENNA. THE VOLTAGE ACROSS THE ANTENNA ELEMENTS AND THE CURRENT THROUGH THEM CREATE THE ELECTRIC AND MAGNETIC WAVES, RESPECTIVELY. AT THE RECEIVER, THE ELECTROMAGNETIC WAVE PASSING OVER THE ANTENNA INDUCES A SMALL VOLTAGE. THUS, THE ANTENNA BECOMES THE SIGNAL SOURCE FOR THE RECEIVER INPUT.

PIEZOELECTRIC TRANSDUCER

PIEZOELECTRIC EFFECT IS THE ABILITY OF CERTAIN MATERIALS TO GENERATE AN ELECTRIC CHARGE IN RESPONSE TO APPLIED MECHANICAL STRESS. PIEZO ELECTRIC EFFECT

(iii)

$$\begin{array}{r} 1\ 1\ 1\ 1 \\ \times\ 1\ 0\ 0\ 1 \\ \hline 1\ 1\ 1\ 1 \\ 0\ 0\ 0\ 0 \\ 0\ 0\ 0\ 0 \\ 1\ 1\ 1\ 1 \\ \hline 1\ 0\ 0\ 0\ 0\ 1\ 1\ 1 \end{array}$$

15.2.4 Binary Division

Division in binary follows the same procedure as division in decimal. Division by 0 is meaningless. An example is given below.

Example 15.6 Perform the following divisions: (i) $110 \div 10$ (ii) $1111 \div 110$

Solution: (i) $110 \div 10$

$$\begin{array}{r} 11_2 \\ 10\overline{)110} \\ 10 \\ \hline 10 \\ 10 \\ \hline 00 \end{array}$$

(ii) $1111 \div 110$

$$\begin{array}{r} 10.1_2 \\ 110\overline{)1111.0} \\ 110 \\ \hline 110 \\ 110 \\ \hline 000 \end{array}$$

$$\begin{array}{r} 3_{10} \\ 2\overline{)6} \\ 6 \\ \hline 0 \end{array}$$

$$\begin{array}{r} 2.5_{10} \\ 6\overline{)15.0} \\ 12 \\ \hline 30 \\ 30 \\ \hline 00 \end{array}$$

15.3 1'S AND 2'S COMPLEMENTS

The usefulness of the complement numbers stems from the fact that subtraction of a number from another can be accomplished by adding the complement of the subtrahend to the minuend. The actual difference can be obtained with minor manipulations.

15.3.1 1's Complement Subtraction

Subtraction of binary numbers can be accomplished by using the 1's complement method, which allows us to subtract using only addition. The 1's complement of a binary number is found by simply changing all 1s to 0s and all 0s to 1s. To subtract a smaller number from a larger number, the 1's complement method is as follows:

1. Determine the 1's complement of the smaller number.
2. Add the 1's complement to the larger number.
3. Remove the carry and add it to the result. This carry is called ***end-around-carry***.

Example 15.7 Subtract 1010_2 from 1111_2 using 1's complement method. Show direct subtraction for comparison.

Solution: Direct subtraction

$$\begin{array}{r} 1\ 1\ 1\ 1 \\ -1\ 0\ 1\ 0 \\ \hline 0\ 1\ 0\ 1 \end{array}$$

1's complement method

$$\begin{array}{r} 1\ 1\ 1\ 1 \\ 0\ 1\ 0\ 1 \\ \hline 1\ 0\ 1\ 0\ 0 \\ \text{carry} \quad\quad\ \ 1 \\ \text{add carry} \\ \hline 0\ 1\ 0\ 1 \end{array} \qquad 1\text{'s comp.} \rightarrow$$

(x) Radioacoustic : Geiger Muller, Radio

To subtract a larger number from a smaller one, the 1's complement method is as follows:

1. Determine the 1's complement of the larger number.
2. Add the 1's complement to the smaller number.
3. The answer has an opposite sign and is the 1's complement of the result. There is no carry.

Example 15.8 Subtract 1010_2 from 1000_2 using 1's complement method. Show direct subtraction for comparison.

Solution: Direct subtraction

$$\begin{array}{r} 1\ 0\ 0\ 0 \\ -1\ 0\ 1\ 0 \\ \hline -0\ 0\ 1\ 0 \end{array}$$

1's complement method

$$1\ 0\ 0\ 0 \xrightarrow{\text{1's comp.}} \begin{array}{r} 0\ 1\ 0\ 1 \\ \hline 1\ 1\ 0\ 1 \end{array}$$

No carry results and the answer is the 1's complement of 1101 and opposite sign, i.e. – 0010.

The 1's complement method is particularly useful in arithmetic logic circuits because subtraction can be accomplished with an adder.

15.3.2 2's Complement Subtraction

The 2's complement of a binary number is found by adding 1 to its 1's complement. To subtract a smaller number from a larger one, the 2's complement method is applied as follows:

1. Determine the 2's complement of the smaller number.
2. Add the 2's complement to the larger number.
3. Discard the carry (there is always a carry in this case).

Example 15.9 Subtract 1010_2 from 1111_2 using 2's complement method. Show direct subtraction for comparison.

Solution: Direct subtraction

$$\begin{array}{r} 1\ 1\ 1\ 1 \\ -1\ 0\ 1\ 0 \\ \hline 0\ 1\ 0\ 1 \end{array}$$

2's complement method

$$\begin{array}{r} 1\ 1\ 11 \\ 0\ 1\ 10 \\ \hline \text{carry}\quad 1\ 0\ 1\ 01 \end{array}$$

The carry is discarded. Thus, the answer is 0101_2.

To subtract a larger number from a smaller one, the 2's complement method is as follows:

1. Determine the 2's complement of the larger number.
2. Add the 2's complement to the smaller number.
3. There is no carry. The result is in 2's complement form and is negative.
4. To get an answer in true form, take the 2's complement and change sign.

Example 15.10 Subtract 1010_2 from 1000_2 using 2's complement method. Show direct subtraction for comparison.

Solution: Direct subtraction

$$\begin{array}{r} 1\ 0\ 0\ 0 \\ -1\ 0\ 1\ 0 \\ \hline 0\ 0\ 1\ 0 \end{array}$$

2's comp.→ no carry

2's complement method

$$\begin{array}{r} 1\ 0\ 0\ 0 \\ 0\ 1\ 1\ 0 \\ \hline 1\ 1\ 1\ 0 \end{array}$$

No carry results. Thus, the difference is negative and the answer is the 2's complement of 1110_2, i.e. 0010_2.

Both 1's and 2's complement methods of subtraction may seem more complex compared to direct subtraction. However, they both have distinct advantages when implemented with logic circuits because they allow subtraction to be done using addition. Both 1's and the 2's complements of a binary number are relatively easy to accomplish with logic circuits; and the 2's complement has an advantage over the 1's complement in that an end-around-carry operation does not have to be performed.

15.4 BINARY CODED DECIMAL

When a computer is handling numbers in binary but in group of four digits, the number system is called Binary Coded Decimal (BCD). Combinations of binary digits that represent numbers, letters, or symbols are digital codes. The 8421 code is a type of binary coded decimal code. It has four bits and represents the decimal digits 0 through 9. The designation 8421 indicates the binary weights of the four bits. The case of conversion between 8421 code numbers and the familiar decimal numbers is the main advantage of this code. To express any decimal number in BCD, simply replace each decimal digit by the appropriate four-bit code. Table 15.1 gives the binary and BCD for the decimal numbers 0 through 15.

Table 15.1 Decimal numbers, equivalent binary and BCD

Decimal number	*Binary number*	*Binary coded decimal (8421)*
0	0000	0000
1	0001	0001
2	0010	0010
3	0011	0011
4	0100	0100
5	0101	0101
6	0110	0110
7	0111	0111
8	1000	1000
9	1001	1001
10	1010	0001 0000
11	1011	0001 0001
12	1100	0001 0010
13	1101	0001 0011
14	1110	0001 0100
15	1111	0001 0101

15.4.1 BCD Addition

BCD is a numerical code, and many applications require that arithmetic operations be performed. Addition is the most important operation because the other three operations like subtraction, multiplication and division can be accomplished using addition. The rule for adding two BCD numbers is given below.

1. Add the two numbers, using the rules for binary addition.
2. If a four-bit sum is equal to or less than 9, it is a valid BCD number.
3. If a four-bit sum is greater than 9, or if a carry-out of the group is generated, it is an invalid result. Add 6 (0110_2) to the four-bit sum in order to skip the six invalid states and return the code to 8421. If a carry results when 6 is added, simply add the carry to the next four-bit group.

Example 15.11 Add the following BCD numbers:

(i)

```
    1 0 0 1          9
  + 0 1 0 0        + 4
  -------          ----
    1 1 0 1        Invalid BCD number      13(10)
  + 0 1 1 0        Add 6
  -------
0 0 0 1 0 0 1 1    Valid BCD number
    ↓       ↓
    1       3
```

(ii)

```
  0 0 0 1 1 0 0 1          19
+ 0 0 0 1 0 1 0 0        + 14
-----------------        ----
  0 0 1 0 1 1 0 1        Right group is invalid   33(10)
      + 0 1 1 0          Add 6
-----------------
  0 0 1 1 0 0 1 1        Valid BCD number
    ↓       ↓
    3       3
```

15.5 BOOLEAN ALGEBRA

Boolean algebra is a set of rules, laws, and theorems by which logical operations can be expressed mathematically. It is a convenient and systematic way of expressing and analyzing the operation of digital circuits and systems. In Boolean algebra, a variable can be either a zero or a one. The binary digits are utilized to represent the two levels that occur within digital logic circuits. A binary 1 will represent a HIGH level and a binary 0 will represent a LOW level. The complement of a variable is represented by a 'bar' over the letter; for example, the complement of A is represented by $\bar{A}$.

15.5.1 Boolean Addition and Multiplication

Boolean addition involves variables having values of either a binary 1 or a 0. The basic rules for Boolean addition are as follows:

$$0 + 0 = 0$$
$$0 + 1 = 1$$
$$1 + 0 = 1$$
$$1 + 1 = 1$$

15.6 LOGIC GATES

The basic elements that make up a digital system are called as logic gates. The most common logic gates are OR, AND, NOT, NAND and NOR gates. The NAND and NOR gates are called as universal gates. Exclusive-OR gate is another logic circuit which can be constructed using AND, OR and NOT gates.

15.6.1 OR Gate

The OR gate performs logical addition, commonly known as OR function. The OR gate has two or more inputs and only one output. The operation of OR gate is such that a high (1) on the output is produced when any of the inputs is high (1). The output is low (0) only when all the inputs are low (0).

As shown in Fig. 15.1, A and B represent the inputs and Y the output. Resistance R is the load resistance.

If $A = 0$ and $B = 0$ then $V_0 = 0$ and $Y = 0$.

If $A = 1$ and $B = 0$, diode D_1 will conduct and so the output $Y = 1$.

If $A = 0$ and $B = 1$, diode D_2 will conduct and the output $Y = 1$.

If $A = 1$ and $B = 1$, both the diodes will conduct and so the output $Y = 1$.

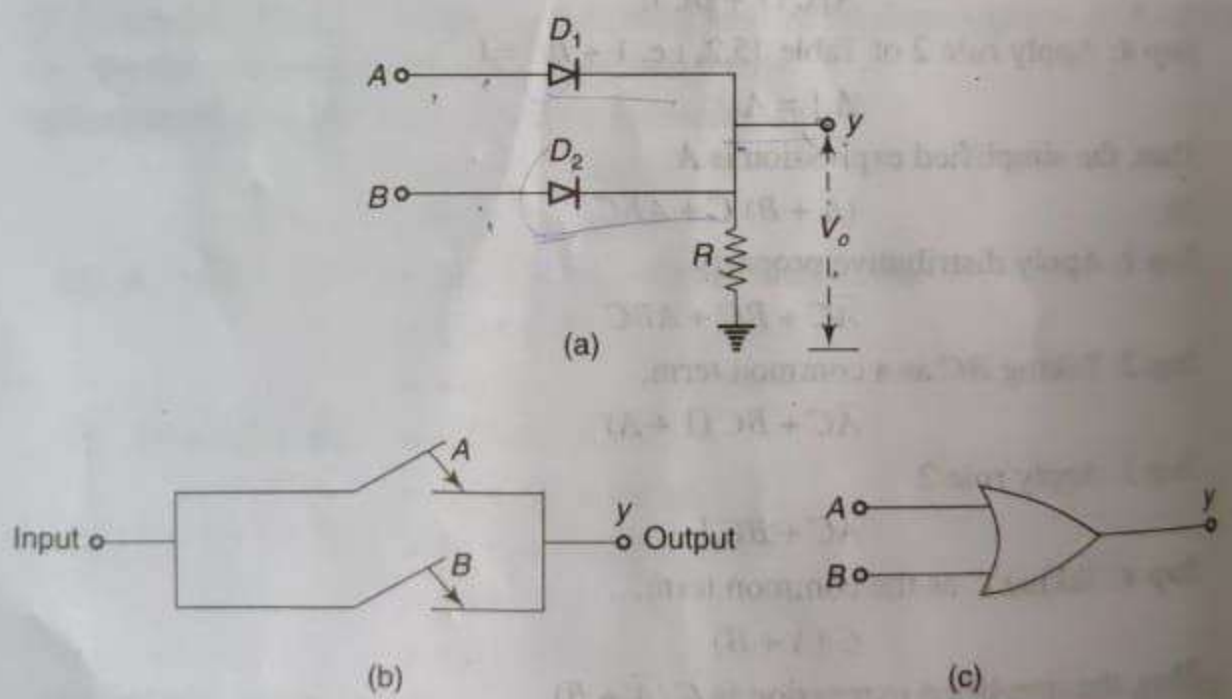


Fig. 15.1 (a) Circuit diagram of an OR gate, (b) Electrical equivalent of an OR gate, (c) Logic symbol

The electrical equivalent circuit of an OR gate is shown in Fig. 15.1(b) where switches A and B are connected in parallel with each other. If either A, B or both are closed, then the output will result. The logic symbol for OR gate is shown in Fig. 15.1(c). The logic operation of the two input OR gate is described in the truth table shown in Table 15.3.

Table 15.3 Truth table for the two-input OR gate

Input		Output
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

15.6.2 AND Gate

The AND gate performs logical multiplication, commonly known as AND function. The AND gate has two or more inputs and a single output. The output of AND gate is high only when all the inputs are high. When any of the inputs is low, the output is low.

As shown in the Fig. 15.2(a), A and B represent the inputs and Y represents the output.

If $A = 0$ and $B = 0$, both diodes conduct as they are forward biased and the output $Y = 0$.

If $A = 0$ and $B = 1$, diode D_1 conducts and D_2 does not conduct, and again the output $Y = 0$.

If $A = 1$ and $B = 0$, diode D_1 does not conduct and D_2 conducts, and the output $Y = 0$.

If $A = 1$ and $B = 1$, both the diodes do not conduct as they are reverse based and so the output $Y = 1$.

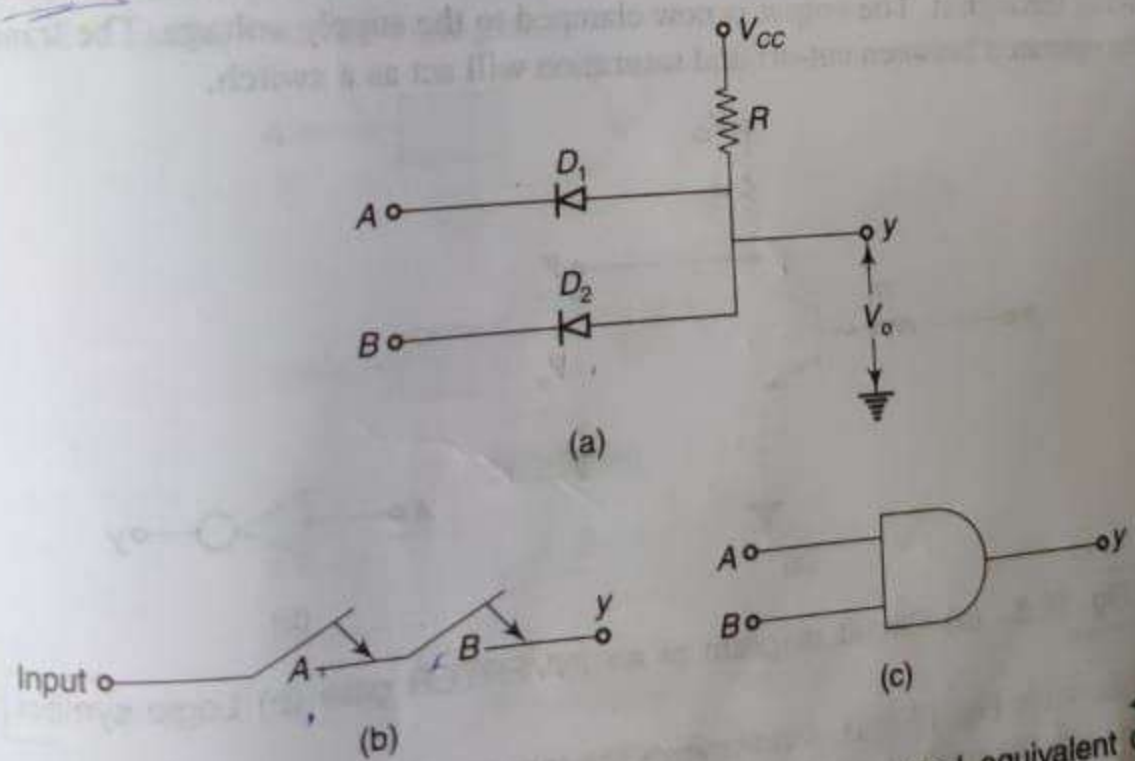


Fig. 15.2 (a) Circuit diagram of an AND gate, (b) Electrical equivalent of an AND gate, (c) Logic symbol

The electrical equivalent circuit of an AND gate is shown in Fig. 15.2 (b) where two switches A and B are connected in series. If both A and B are closed, then only output will result. Logic symbol of the AND gate is shown in Fig. 15.2(c). The logic operation of the two input AND gate is described in the truth table shown in Table 15.4.

Table 15.4 Truth table for a two-input AND gate

Input		*Output*
A	*B*	*Y*
0	0	0
0	1	0
1	0	0
1	1	1

15.6.3 NOT Gate (Inverter)

The NOT gate performs a basic logic function called inversion or complementation. The purpose of the gate is to change one logic level to opposite level. It has one input and one output. When a high level is applied to an inverter input, a low level will appear at its output and vice-versa. The operation of the circuit can be explained as follows. When a high voltage is applied to the base of the transistor, base current increases and the transistor is saturated. The transistor now acts as a closed switch and conducts heavily. Thus the output voltage is logic 0. On the other hand, when a low voltage is applied at the base, the transistor is cut-off due to very low or no base current. Now, the transistor can be considered as an open switch, with no current flowing through it. The output is now clamped to the supply voltage. The transistor when operated between cut-off and saturation will act as a switch.

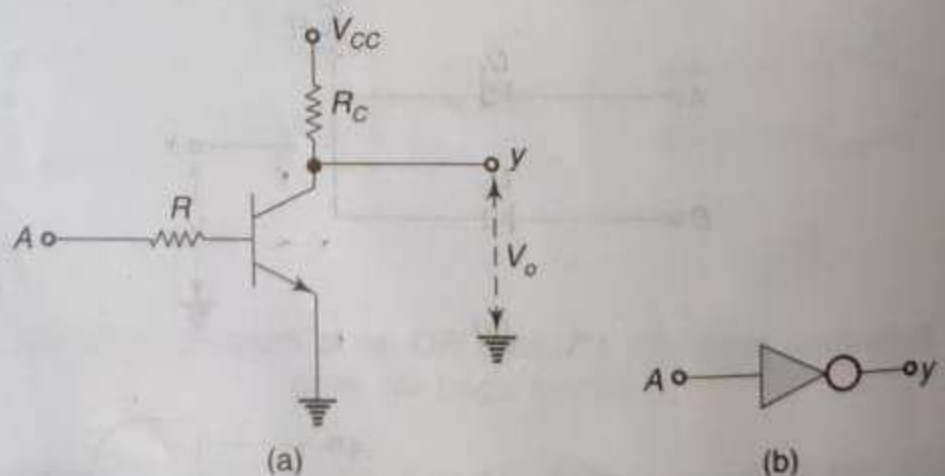


Fig. 15.3 (a) Circuit diagram of an INVERTER gate (b) Logic symbol

As shown in Fig. 15.3(a), A represents the input and y represents the output. If the input is high, the transistor is in ON state and the output is low. If the input is low, the transistor is in OFF state and the output is high. The symbol for the inverter is shown in Fig. 15.3(b). The truth table is given in Table 15.5.

Table 15.5 Truth table for an INVERTER

Input A	Output Y
0	1
1	0

15.6.4 NAND Gate

NAND is a contraction of NOT–AND. It has two or more inputs and only one output. When all the inputs are high, the output is low. If any of the inputs is low, the output is high. The logic symbol for the NAND gate is shown in Fig. 15.4.

The truth-table for the NAND gate is shown in Table 15.6.

Table 15.6 Truth table for NAND gate

Input A	Input B	Output y
0	0	1
0	1	1
1	0	1
1	1	0

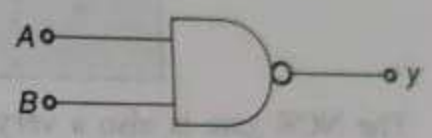
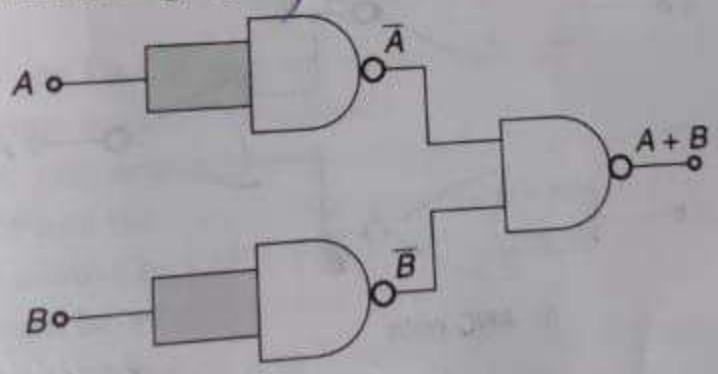
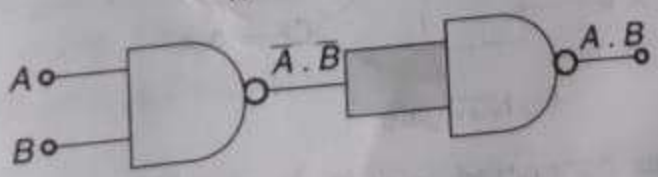


Fig. 15.4 Logic symbol for the NAND gate

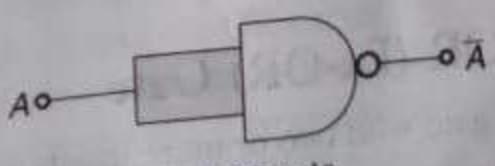
The NAND gate is a very popular logic function because it is an universal function; that is, it can be used to construct an AND gate, an OR gate, and INVERTER or any combination of these functions. Figure 15.5 shows how NAND gates can be connected to realize various logic gates.



(i) OR gate



(ii) AND gate



(iii) NOT gate

Fig. 15.5 NAND gates connected to realize (a) OR (b) AND and (c) NOT gates

15.6.5 NOR Gate

Fig. 15.6 Logic symbol for NOR gate

NOR is a contraction of NOT–OR. It has two or more inputs and only one output. Only when all the inputs are low, the output is high. If any of the inputs is high, the output is low. The logic symbol for the NOR gate is shown in Fig. 15.6.

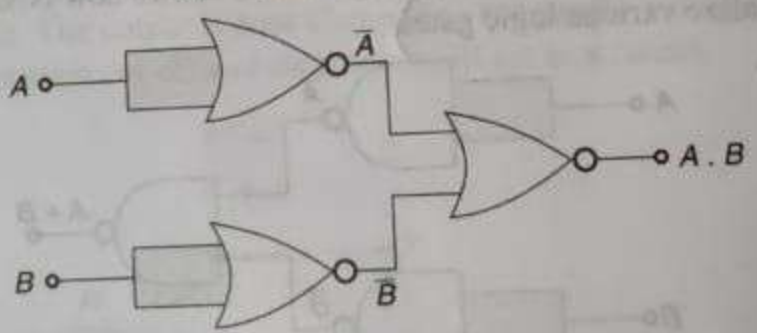
The truth-table for the NOR gate is shown in Table 15.7.

Table 15.7 Truth table for NOR gate

Input		*Output*
A	*B*	*Y*
0	0	1
0	1	0
1	0	0
1	1	0

The NOR gate is also a very popular logic function because it is also an universal function; that is, it can be used to construct an AND gate, an OR gate, and INVERTER or any combination of these functions. Figure 15.7 shows how NOR gates can be connected to realize various logic gates.

(i) OR gate



(ii) AND gate

(iii) NOT gate

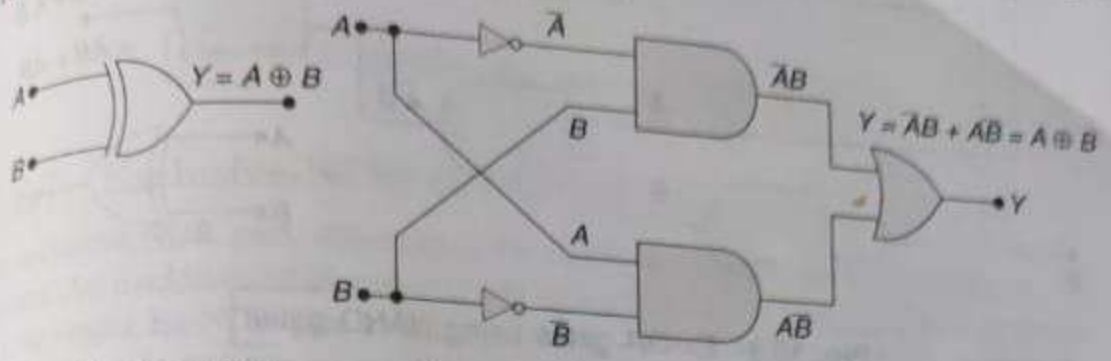
Fig. 15.7 NOR gates connected to realize (a) OR (b) AND and (c) NOT gates

15.6.6 Exclusive–OR (Ex-OR) Gate

An Exclusive-OR Gate is a gate with two or more inputs and one output. The output of a two-input Ex-OR gate assumes a HIGH state if one and only one input assumes

a HIGH state. This is equivalent to saying that the output is HIGH if either input A or input B is HIGH exclusively, and low when both are 1 or 0 simultaneously.

The logic symbol for the Ex-OR gate is shown in Fig. 15.8 (a) and the truth table for the Ex-OR operation is given in Table 15.8.



(a) Logic symbol (b) Using AND-OR-NOT gates

Fig. 15.8 Ex-OR gate

Table 15.8 Truth table of a 2-input Ex-OR gate

Input		*Output*
A	*B*	$Y = A + B$
0	0	0
0	1	1
1	0	1
1	1	0

The truth table of the Ex-OR gate shows that the output is HIGH when any one, but not all, of the inputs is at 1. This exclusive feature eliminates a similarity to the OR gate. The Ex-OR gate responds with a HIGH output only when an odd number of inputs is HIGH. When there is an even number of HIGH inputs, such as two or four, the output will always be LOW. From the truth table of a 2-input Ex-OR gate, the Ex-OR function can be written as $Y = \bar{A}B + A\bar{B} = A \oplus B$.

The above expression can be read as Y equals A Ex-OR B. Using the above expression, a 2-input Ex-OR gate can be implemented using basic gates like AND, OR and NOT gates as shown in Fig. 15.8.

The 2-input Ex-OR gate can also be implemented using NAND gates as shown in Fig. 15.9.

The main characteristic property of an Ex-OR gate is that it can perform modulo-2 addition. It should be noted that the same Ex-OR truth table applies when adding two *binary digits* (bits). A 2-input Ex-OR circuit is, therefore, sometimes called a *module-2-adder* or a *half-adder* without carry output. The name half-adder refers to the fact that possible carry-bit, resulting from an addition of two preceding bits, has not been taken into account. A full addition is performed by a second Ex-OR circuit

catridge etc...

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transr

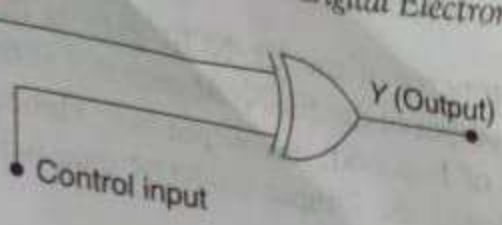

Fig. 15.11 Ex-OR gate as a controlled inverter

15.6.7 Exclusive-NOR (Ex-NOR) Gate

The exclusive-NOR gate, abbreviated Ex-NOR, is an Ex-OR gate, followed by an inverter. An Exclusive-NOR gate has two or more inputs and one output. The output of a two-input Ex-NOR gate assumes a HIGH state if both the inputs assume the same logic state or have an even number of 1s, and its output is LOW when the inputs assume different logic states or have an odd number of 1s. The logic symbol of Ex-NOR gate is shown in Fig. 15.12 and its truth table is given in Table 15.9. From the truth table, it is clear that the Ex-NOR output is the complement of the Ex-OR gate. The Boolean expression for the Ex-NOR gate is

$$Y = \overline{A \oplus B}$$

Read the above expression as "Y equals A Ex-NOR B". According to DeMorgan's theorem.

$$\begin{aligned}\overline{A \oplus B} &= \overline{\overline{A}B + A\overline{B}} \\ &= \overline{\overline{A}B}.\,\overline{A\overline{B}} \\ &= (A + \overline{B})\,(\overline{A} + B) \\ &= AB + \overline{A}\,\overline{B}\end{aligned}$$

Table 15.9 Truth table of 2-input Ex-NOR gate

Input		Output
A	B	$Y = \overline{A \oplus B}$
0	0	1
0	1	0
1	0	0
1	1	1

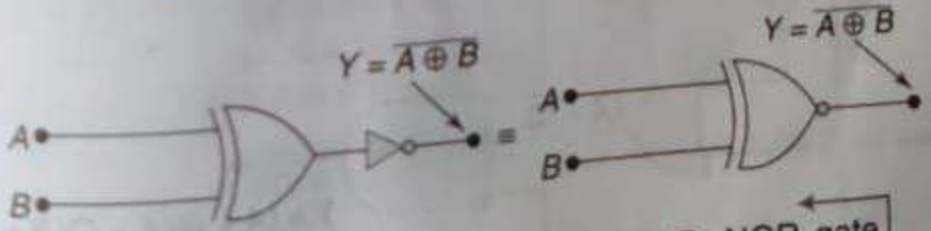

Fig. 15.12 Logic symbol of 2-input Ex-NOR gate

An important property of the Ex-NOR gate is that it can be used for bit comparison. The output of an Ex-NOR gate is 1 if both the inputs are similar, i.e. both are 0 or 1; otherwise, its output is 0. Hence, it can be used as a one-bit comparator. It is also called a *coincidence circuit*.

Electromagnetic : Antenna, Hall effect; Mag
catridge etc...

Each individual term in the standard SOP form is called as minterm and in the standard POS form as maxterm. An important characteristics of sum-of-products and product-of-sums forms is that the corresponding implementation is always a two-level gate network; hence, the maximum number of gates through which a signal must pass in going from an input to the output is two, excluding inversions.

15.8 KARNAUGH MAP REPRESENTATION OF LOGICAL FUNCTIONS

Karnaugh map technique provides a systematic method for simplifying and manipulating Boolean expressions. In this technique, the information contained in a truth table or available in POS or SOP form is represented on Karnaugh map (K-map). In an n-variable K-map there are 2^n cells. Each cell corresponds to one of the combinations of n variables. Therefore, we see that for each row of the truth table, i.e. for each minterm and for each maxterm, there is one specific cell in the K-map. The variables have been designated as A, B, C and D, and the binary numbers formed by them are taken as AB, ABC, and $ABCD$ for two, three and four variables, respectively. The K-map for two, three and four variables are shown in Fig. 15.20.

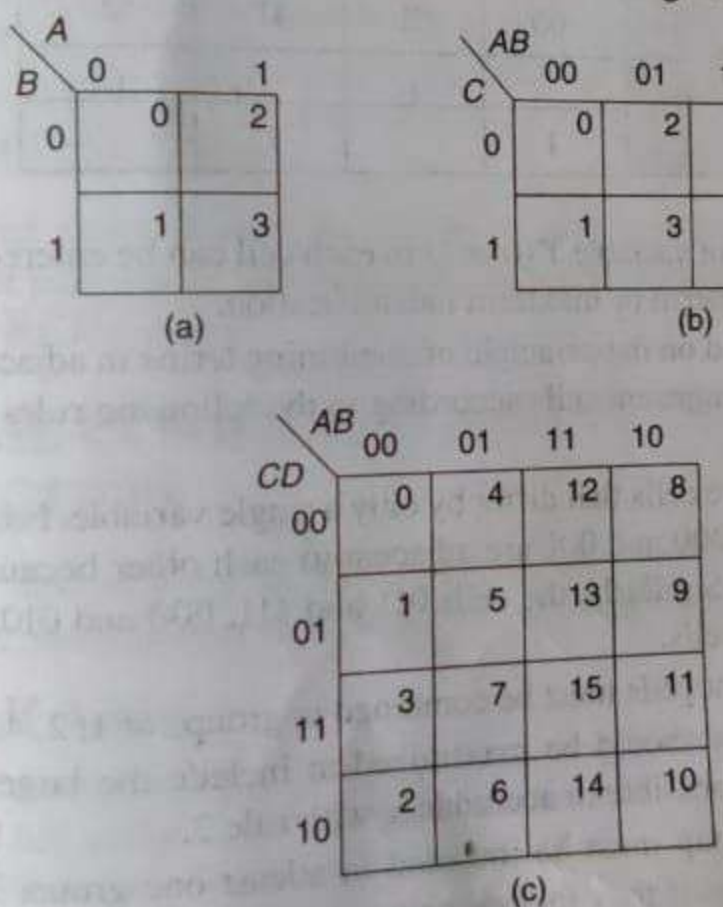

Fig. 15.20 Karnaugh maps: (a) Two-variable (b) Three-variable (c) Four-Variable

The entries in a truth table can be represented in a K-map as discussed below. Consider the truth table shown in Table 15.10.

Table 15.10 Truth table of a digital system

Inputs			Output
A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	0
1	1	1	1

The output Y can be written as,

$$Y = \bar{A}\bar{B}C + \bar{A}B\bar{C} + A\bar{B}\bar{C} + ABC$$

The K-map for the above expression is shown below.

Variables		$\bar{A}\bar{B}$ 00	$\bar{A}B$ 01	AB 11	$A\bar{B}$ 10
$\bar{C}$	0		1		1
C	1	1		1	

The value of the output variable Y (0 or 1) in each cell can be entered corresponding to its decimal or minterm or maxterm indentification.

Simplification is based on the principle of combining terms in adjacent cells. One can group 1s that are in adjacent cells according to the following rules by drawing a loop around those cells:

1. Adjacent cells are cells that differ by only a single variable. For example, the cells numbered 000 and 001 are adjacent to each other because they differ by only one bit. Similarly, the cells 011 and 111, 000 and 010, 100 and 110 are all adjacent cells.
2. The 1s in adjacent cells must be combined in groups of 1, 2, 4, 8 and so on.
3. Each group of 1s should be maximized to include the largest number of adjacent cells as possible in accordance with rule 2.
4. Every 1 on the map must be included in atleast one group. There can be overlapping groups if they include common 1s.

Grouping is illustrated by the following example.

Example 15.19 Simplify the K-map shown below.

Variables		$\bar{A}\bar{B}$ 00	$\bar{A}B$ 01	AB 11	$A\bar{B}$ 10
$\bar{C}$	0	1			1
C	1		1	1	

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EASY QUESTIONS

1.A transducer converting ground movement or velocity to voltage is known as _____
a) Geophone
b) Pickup
c) Hydrophone
d) Sonar transponder
Answer: A
2.Which is the example of a active transducer?
a) Strain gauge
b) Thermistor
c) LVDT
d) Thermocouple
Answer:D
3. Which transducer is known as ‘self-generating transducer
a) Active transducer
b) Passive transducer
c) Secondary transducer
d) Analog transducer
Answer:A
4. What is the relation between scale factor and sensitivity of a transducer?
a) Scale factor is double of sensitivity
b) Scale factor is inverse of sensitivity
c) Sensitivity is inverse of scale factor
d) Sensitivity is equal to scale factor
Answer: B
5.Which of the following is an analog transducer?
a) Encoders
b) Strain gauge
c) Digital tachometers
d) Limit switches
Answer:B
6.What is the principle of operation of LVDT?
a) Mutual inductance
b) Self-inductance
c) Permanence
d) Reluctance
Answer:A
7.Which of the following can be measured using Piezo-electric transducer?
a) Velocity
b) Displacement

c) Force
d) Sound
Answer:C
8.Capacitive transducer are used for?
a) Static measurement
b) Dynamic measurement
c) Transient measurement
d) Both static and dynamic
Answer:B
.9. Which of the following is used in photo conductive cell?
a) Selenium
b) Quartz
c) Rochelle salt
d) Lithium sulphate
Answer:A
10.Mechanical transducers sense _____
a) electrical changes
b) physical changes
c) chemical changes
d) biological changes
Answer:B
11.Mechanical transducers generate _____
a) electrical signals
b) chemical signals
c) physical signals
d) biological signals
Answer:C
12.Electrical transducers generate _____
a) biological signals
b) chemical signals
c) physical signals
d) electrical signals
Answer:D
13.The power needs of electrical transducers is _____
a) maximum
b) minimum
c) zero
d) infinite
Answer:B
14.Electrical transducers are _____
a) small and non-portable
b) large and non-portable
c) small and compact
d) large and portable
Answer:C
15.Potentiometer transducers are used for the measurement of
A. Pressure
B. Displacement
C. Humidity
D. Both (a) and (b)
Answer:D
16.Thermistor is a transducer. Its temperature coefficient is
A. Negative
B. Positive
C. Zero

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unit 4-5 one marka

Date 12-02-2021

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1.A transducer converting ground movement or velocity to voltage is known as _____
a) Geophone
b) Pickup
c) Hydrophone
d) Sonar transponder
Answer: A
2.Which is the example of a active transducer?
a) Strain gauge
b) Thermistor
c) LVDT
d) Thermocouple
Answer:D
3. Which transducer is known as ‘self-generating transducer
a) Active transducer
b) Passive transducer
c) Secondary transducer
d) Analog transducer
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c) Sensitivity is inverse of scale factor
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c) Permanence
d) Reluctance
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b) Displacement

c) Force
d) Sound
Answer:C
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b) Dynamic measurement
c) Transient measurement
d) Both static and dynamic
Answer:B
.9. Which of the following is used in photo conductive cell?
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b) Quartz
c) Rochelle salt
d) Lithium sulphate
Answer:A
10.Mechanical transducers sense _____
a) electrical changes
b) physical changes
c) chemical changes
d) biological changes
Answer:B
11.Mechanical transducers generate _____
a) electrical signals
b) chemical signals
c) physical signals
d) biological signals
Answer:C
12.Electrical transducers generate _____
a) biological signals
b) chemical signals
c) physical signals
d) electrical signals
Answer:D
13.The power needs of electrical transducers is _____
a) maximum
b) minimum
c) zero
d) infinite
Answer:B
14.Electrical transducers are _____
a) small and non-portable
b) large and non-portable
c) small and compact
d) large and portable
Answer:C
15.Potentiometer transducers are used for the measurement of
A. Pressure
B. Displacement
C. Humidity
D. Both (a) and (b)
Answer:D
16.Thermistor is a transducer. Its temperature coefficient is
A. Negative
B. Positive
C. Zero

D. Unique
Answer:A
17.Strain gauge is a
A. Active device and converts mechanical displacement into a change of resistance
B. Passive device and converts electrical displacement into a change of resistance
C. Passive device and converts mechanical displacement into a change of resistance
D. Active device and converts electrical displacement into a change of resistance
Answer:C
18.The linear variable differential transformer transducer is
A. Inductive transducer
B. Non-inductive transducer
C. Capacitive transducer
D. Resistive transducer
Answer:A

MODERATE QUESTIONS

1. With the increase in the intensity of light, the resistance of a photovoltaic cell
A. Increases
B. Decreases
C. Remains same
D. Doubled
Answer:B
2. If the displacement is measured with strain gauge then the number of strain gauge normally required are
A. One
B. Two
C. Three
D. Four
Answer:D
3. LEDs fabricated from the gallium arsenide smit radiation in the
A. Visible Range
B. Infrared Region
C. Ultra violet Region
D. Ultrasonic Region
Answer:B
4. In light emitting diode, the available light emitting region is
A. Less than 2.5 mm
B. From 2.5 to 25 mm
C. Greater than 25 mm
D. Greater than 50 mm
Answer:B
5. In liquid crystal displays, the liquid crystal exhibits properties of
A. Liquid
B. Solids
C. Gases
D. Both (a) and (b)
Answer:D
6. The optical properties of liquid crystals depend on the direction of
a) Air
b) Solid
c) Light
d) Water
Answer:C
7. LCDs operate from a voltage ranges from

a) 3 to 15V
b) 10 to 15V
c) 10V
d) 5V
Answer:A
8. LCDs operate from a frequency ranges from
a) 10Hz to 60Hz
b) 50Hz to 70Hz
c) 30Hz to 60Hz
d) None of the Mentioned
Answer:C
9. What is backplane in LCD?
a) The ac voltage applied between segment and a common element
b) The dc voltage applied between segment and a common element
c) The amount of power consumed
Answer:A
10. In photo emissive transducers, electrons are attracted by _____
a) Cathode
b) Anode
c) Grid
d) Body
Answer:B
11.LDR's are also called_____
a) Photo voltaic cell
b) Photo resistive cell
c) Photo emissive cell
d) All of the mentioned
Answer:B
12. In dark, LDR has
A. low resistance
B. high current
C. high resistance
D. both A and B
Answer:C

TOUGH QUESTIONS

31. 1 eV is equal to
A.1.6 × 10-19 J
B. 2.0 × 10-20 J
C. 3 J
D.4 J
Answer:A

32.Solar cell works based on
(a) Laser technology (b) Photo-conduction (c) Thermal emission (c) Tyndall effect
Answer:B

33.Commonly used photoemissive material is _____
a) gold
b) opium
c) tellurium
d) cesium-antimony
Answer:D

34.Photoconductors are made of _____
a) thick layer of semiconductor
b) thin layer of semiconductor
c) capacitive substrate
d) inductive substrate
Answer:B

35.A device consists of a phototransistor and a led is
A. Photodiode
B. Optocoupler
C. Optoisolator
D. Photomultiplier
Answer:B
36.A load cell is essentially a
(a) strain gauge (b) thermister (c) resistive potentiometer (d) inductive transducer
Answer:A

UNIT – 5 DIGITAL SYSTEMS

EASY QUESTIONS

1. Communication is the transfer of meaningful information from
(a) source to destination (b) transmitter to receiver
(c) sender to receiver (d) above all
ANSWER:D
2.The basic process of information exchange between transmitter and receiver is known as…..
(a) communication (b) controlling (c) signaling (d) modulating
ANSWER:A

3. The process of converting electrical equivalent of the information to a suitable form is done by….
(a) transmitter (b) receiver (c) medium (d) above all
ANSWER:A

4. The communication system with wire as conducting medium is known as ……
(a) wired communication (b) line communication
(c) guided media communication (d) above all

ANSWER:D

5.The communication system which has no wires as conducting medium is known as…..
(a) wireless communication (b) radio communication
(c) unguided communication (d) above all
ANSWER:D

6. Noise is basically a……
(a) random signal (b) unwanted electrical signal
(c) disturbance signal (d) above all
ANSWER:D

7. The process of varying amplitude of sine wave carrier signal according to the instantaneous voltage of sine wave modulating signal is known as ….
(a) Frequency Modulation (b) Phase modulation
(c) Amplitude modulation (d) PAM
ANSWER:C

8. The loss of information in AM wave is known as…
(a) under modulation (b) over modulation
(c) attenuation (d) rectification
ANSWER:B

9. Each product term of a group, a'.b.c' and a.b, represents the _____in that group.
a) Input
b) POS
c) Sum-of-Minterms
d) Sum of Maxterms
ANSWER:C

10. Each "1" entry in a K-map square represents:
a) A HIGH for each input truth table condition that produces a HIGH output
b) A HIGH output on the truth table for all LOW input combinations
c) A LOW output for all possible HIGH input conditions
d) A DON'T CARE condition for all possible input truth table combinations
ANSWER:A

11. Which of the following expressions is in the sum-of-products form?
a) (A + B)(C + D)
b) (A * B)(C * D)
c) A* B *(CD)
d) A * B + C * D
ANSWER:D

12. K-Map of full adder is of ------ variables
A. 2 b. 3 c.4 d.1
ANSWER:B

13. The output of a logic gate is 1 when all its inputs are at logic 1, the gate is either
(a) A NAND or a NOR
(b) An AND or an OR
(c) An OR or an X-OR
(d) An AND or a NOR

ANSWER:B

14. The output of a logic gate is 1 when all its inputs are at logic 0. The gate is either
(a) A NAND or a NOR
(b) An AND or an X-OR
(c) An OR or a NAND
(d) An X-OR or an X-NOR
ANSWER:A
15. The most suitable gate to check whether the number of 1's in a digital word is even or odd is
(a) X-OR (b) NAND (c) NOR (d) AND, OR and NOT
ANSWER:A
16. The number of rows in the truth table of a 4- input gate is,
(a) 4 (b) 8 (c) 12 (d) 16
ANSWER:D

17. For checking the parity of a digital word, it is preferable to use
(a) AND gates (b) NAND gates (c) X-OR gates (d) NOR gates
ANSWER:C

18. A+AB+ABC+ABCD+ABCDE…. =
(a) 1 (b) A (c) A+AB (d) AB
ANSWER:B
MODERATE QUESTIONS

1. A swithching function F(a,b,c,d)=a'b'cd+a'bc'd+a'bcd+ab'c'd+ab'cd
a. ∑m(1,2,4,5,7) b. ∑m(3,5,7,9,13) c. ∑m(3,5,7,9,11) d. ∑m(3,7,9,11,13)
ANSWER: C
2. The function F(a,b,c,d)= ∑m(5,9,11,14) is equivalent to
a. a'bc'd+ab'c'd+ab'cd+abcd'
b. a'b'c'd+ab'c'd'+ab'cd+ab'cd'
c. a'bc'd+ab'c'd+abcd+ab'cd'
d. a'bc'd+a'b'c'd+ab'cd+a'bcd'
ANSWER:A
3. If SOP form of the function F= a'bc'd+ab'c'd+abcd+ab'cd'
a. F=(a+b'+c+d')(a'+b+c+d')(a'+b'+c'+d')(a'+b+c'+d)
b. F=(a+b'+c+d)(a'+b'+c+d')(a'+b'+c'+d')(a'+b'+c'+d)
c. F=(a'+b'+c+d')(a'+b+c+d')(a+b'+c'+d')(a'+b+c+d)
d. F=(a+b'+c'+d')(a'+b+c+d')(a'+b'+c'+d')(a'+b+c'+d')
ANSWER: A
4. If a 3 variable function is represented in POS form as πM(0, 3,6,7) then in SOP from it is represented as
a. ∑m(1,2,4,6) b. ∑m(1,3,4,5) c. ∑m(1,2,4,5) d. ∑m(1,2,4,7)
ANSWER:C
5. Q.96.A+B=B+A; AB=BA represent which laws
(a) Commutative
(b) Associative
(c) Distributive
(d) Idempotence
ANSWER:A
6. The K-map based Boolean reduction is based on the following Unifying Theorem: A + A' = 1.
a) Impact
b) Non Impact
c) Force

d) Complementarity
ANSWER:B
7. The prime implicant which has at least one element that is not present in any other implicant is known as _____
a) Essential Prime Implicant
b) Implicant
c) Complement
d) Prime Complement
ANSWER:A
8. Product-of-Sums expressions can be implemented using _____
a) 2-level OR-AND logic circuits
b) 2-level NOR logic circuits
c) 2-level XOR logic circuits
d) Both 2-level OR-AND and NOR logic circuits
ANSWER:D
9. There are many situations in logic design in which simplification of logic expression is possible in terms of XOR and _____ operations.
a) X-NOR
b) XOR
c) NOR
d) NAND
ANSWER:A
10. These logic gates are widely used in _____ design and therefore are available in IC form.
a) Sampling
b) Digital
c) Analog
d) Systems
ANSWER:B
11. In cellular transmitter system, the carrier generated by frequency synthesizer uses following modulation by the amplified voice signal from microphone
(a) Frequency modulation (b) Phase modulation
(c) AM modulation (d) None of above
ANSWER:B
12. The modulation index corresponding to maximum deviation and maximum modulating frequency is called as…
(a) modulation index (b) deviation ratio
(c) pre-emphasis factor (d) de- emphasis factor
ANSWER:B
TOUGH QUESTIONS

1) Reduce the expression y=a'b'c'd+a'bc'd+a'bcd+a'bcd'+abc'd'+abc'd+abcd+ab'cd
a) acd+ a'cd+ab'c+a'b'c'
b) a'c'd+a'bc+abc'+acd
c) a'c'd+abc+abc'+a'c'd'
d) ac+a'bc+abc'+acd
ANSWER : B

2) simplify the function f(a,b,c)= ∑m(0,3,4,7)
a) b'c'+bc
b) a'b'+bc
c)a'b'+ab
d)ab'+bc
ANSWER: A
3) (A + B)(A' * B') = ?

a) 1
b) 0
c) AB
d) AB’
ANSWER:B
4. Simplify Y = AB’ + (A’ + B)C.
a) AB’ + C
b) AB + AC
c) A’B + AC’
d) AB + A
ANSWER:A
5. The boolean function A + BC is a reduced form of _____
a) AB + BC
b) (A + B)(A + C)
c) A’B + AB’C
d) (A + C)B
ANSWER:B
6. The canonical sum of product form of the function y(A,B) = A + B is _____
a) AB + BB + A’A
b) AB + AB’ + A’B
c) BA + BA’ + A’B’
d) AB’ + A’B + A’B’
ANSWER:B

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unit 4 short answer

Date 12-02-2021

Time 10:47:49

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1) What is instrument?
It is a device for determining the value or magnitude of a quantity or variable.
2) Add 826 ± 5 to 628 ± 3.
N1 = 826 ± 5 (= ± 0.605%)
N2 = 628 ± 3 (= ± 0.477%)
Sum = 1,454 ± 8 (=± 0.55%)
3) Subtract 628 ± 3 from 826 ± 5.
N1 = 826 ± 5 (= ± 0.605%) N2 = 628 ± 3 (= ± 0.477%)
Difference = 198 ± 8 (= ± 4.04%)
4) List three sources of possible errors in instruments.
Gross Error
Systematic
Random errors.
5) Define Instrumental error.
These are the errors inherent in measuring instrument because of their mechanical structure.
6) Define limiting error.
Components are guaranteed to be within a certain percentage of rated value.
Thus the manufacturer has to specify the deviations from the nominal value of a particular quantity.
7) Define probable error.
It is defined as r = ± 0.6745s where s is standard deviation.Probable error has been used in experimental work to some extent in past, but standard deviation is more convenient in statistical work.
8) Define Environmental error
These are due to conditions in the measuring device, including conditions in the area surrounding the instrument, such as the effects of changes in temperature,humidity.
9) Define arithmetic mean.
The best approximation method will be made when the number of readings would give the best result.
10) Define average deviation.
By definition, average deviation is the sum of absolute values of the value deviations divided by the number of reading.
11) Define units.
It is necessary to define a physical quantity both in kind and magnitude in order to use this information for further proceedings. The standard measure of each kind of physical quantity is named as the unit.
12) Define Standards
The physical embodiment of a unit of measurement is a standard.
For example,the fundamental unit of mass in the international system is the kilogram and defined as the mass of a cubic decimeter of water at its temperature of maximum density of 4°c.

13) Draw the functional block diagram of a measurement system.

14) Mention the purpose of the measurement.
To understand an event or an operation.
To monitor an event or an operation.
To control an event or an operation.
To collect data for future analysis
To validate an engineer design.
15) What are the methods of measurement?
Direct comparison method
Indirect comparison method
16) Define ODDs
The specification of limiting error is in itself uncertain because the manufacture himself is not sure about the accuracy because of the presence of random errors.
17) Classify Standards.
International standards
Primary standards
Secondary standards
Working standards
18) Define transducer and give an example.
Transducer is a device which converts one form of energy into electrical energy.
A thermocouple converts heat energy into electrical voltage.
19) Classify transducer.
On the basis of transduction form used:
As primary and secondary transducers
As active and passive transducers
As analog and digital transducers
As transducers and inverse transducers
20) What is primary transducer?
Bourdon tube acting as a primary transducer senses the pressure and converts the pressure into displacement.
No output is given to the input of the bourdon tube. So it is called primary transducer. Mechanical device can act as a primary transducer.
21) What is secondary transducer?
The output of the Bourdon tube is given to the input of the LVDT.
There are two stages of transduction, firstly the pressure is converted into a displacement by the Bourdon tube then the displacement is converted into analog voltage by LVDT. Here LVDT is called secondary transducer. Electrical device can act as a secondary transducer.
22) What is passive transducer?
In the absence of external power, transducer cannot work and it is called a passive transducer.
Example: capacitive, inductive, resistance transducers.
23) What is active transducer?
In the absence of external power, transducer can work and it is called active transducer.
Example:
velocity, temperature, light can be transduced with the help of an active transducer.
24) What is analog transducer?
These transducers convert the input quantity into an analog output which is a continuous function of time.
Thus a strain gauge, an LVDT, a thermocouple or a thermistors may be called analog transducer, as they give an output which is a continuous function of time.
25) Give the classification of units.
Absolute units
Fundamental and derived units

Electromagnetic units
Electrostatic units
26) Define Primary fundamental and auxiliary fundamental units.
Fundamental units in mechanics are measures of length, mass and time and those are fundamental to most other physical quantities and hence they are called Primary fundamental units.
Measures of certain physical quantities in thermal, electrical and illumination fields are also represented by fundamental units and are used only where those disciplines are involved and hence called auxiliary fundamental units.
27) Define unit of mass preserved at International Bureau of weights and measures at Severes near Paris.
The unit of mass is represented by a material standard: the mass of International prototype kilogram consisting of platinum Iridium hollow cylinder.
28) Define static calibration.
It refers to a process in which all the inputs(desired,modifying,interfering) except one are kept at some constant values.
29) Define Traceability.
The ability to trace the accuracy of the standard back to its ultimate source in fundamental standards of National Institute of Science and Technology is termed “Traceability”.
30) What are random errors or residual errors?
The happenings or disturbances about which we are unaware and lumped together are called random errors or residual errors.
Since these errors remain even after the systematic errors are taken care of,they are called residual errors.
ALSO READ : PLC QUESTIONS & ANSWERS
31) Give one property of piezo-electric crystal.
When a force is applied to piezo-electric crystals, they produce an output voltage.
32) Define an Inverse transducer. Give an example.
A device which converts an electrical quantity into a non-electrical quantity.
A piezo-electric crystal acts as an inverse transducer because when a voltage is applied across its surfaces, it changes its dimensions causing a mechanical displacement.
33) List the factors responsible in selection of a transducer.
Operating principle
Sensitivity
Operating range.
Accuracy.
34) Define static characteristics.
Static characteristics of a measurement system are, in general, those that must be considered when the system or instrument is used to measure a condition not varying with time.
35) Mention different types of static characteristics.
Accuracy
Sensitivity
Reproducibility
Drift
Static error and
Dead zone.
36) What are dynamic characteristics?
Many measurements are concerned with rapidly varying quantities and, therefore, for such cases we must examine the dynamic relations which exist between the output and the input .
This is normally done with the help of differential equations. Performance criteria based upon dynamic relations constitute the Dynamic Characteristics.
37) Mention different types dynamic characteristics?

Zero- order transducers
First – order transducers
Second-order transducers
Higher-order transducers
38) What are the test inputs of the transducer?
Impulse input
Step input
Ramp input
Parabolic input
Sinusoidal input
39) Define zero order transducer.
The input- output relationship of a zero- order transducer is given by
$Y(t) = K\, r(t)$
Where r(t) is the input, Y(t) is the output and K is the static sensitivity of the transducer.
Example for zero-order transducer is a potentiometer.
40) What is mathematical model?
Mathematical model is defined as the mathematical representation of the system and its process.
41) What is frequency response of ZOT?
Frequency response is thus defined as the steady – state output of a transducer when it is excited with sinusoidal input.
The frequency response is represented with the help of two plots namely amplitude radio verses frequency and phase angle shift versus frequency.
42) What is damping ratio?
The damping ratio V is an important parameter which decides the nature of oscillation in the transducer output.
WhenV =0, the second order system is said to be undamped and the system behaves like an oscillator. WhenV =1, the second order system is said to be critical damped and when V >1 , the second – order system is said to be over damped.
43) Define static sensitivity
Sensitivity should be taken depending on the operating point. The sensitivity is expressed in
S = output unit/ input unit.
44) Define linearity.
Linearity is a measure of the maximum deviation of the plotted transducer response from a specified straight line.
45) Compare accuracy and precision.
Accuracy is the closeness to true value whereas precision is the closeness amongst the readings.
Precision is the degree of closeness with which a given value may be repeatedly measured.
46) What is Threshold?
When the input to a transducer is increased from zero, there is a minimum value below which no output can be detected .
This minimum value of the input is defined as the threshold of the transducer.
47) Define resolution.
When the input to a transducer is increased slowly from some non-zero arbitrary value, the change in output is not detected at all until a certain input increment is exceeded. This increment is defined as the resolution.
48) Define hysteresis.
When the input to a transducer which is initially at rest is increased from zero to full-scale and then decreased back to zero, there may be two output values for the same input.
Hysteresis effects can be minimized by taking readings corresponding to ascending and descending values of the input and then taking their arithmetic average.

49) What is range and span?
The range of the transducer is specified as from the lower value of input to higher value of input.
The span of the transducer is specified as the difference between the higher and lower limits of recommended input values.
50) What is rise time?
It is defined as time required for the system to rise from 0 to 100 per cent of its final value.
51) A thermometer has a time constant of 3.5 s. it is quickly taken from a temperature degree celsius to a water bath having temperature 100degree celsius. What temperature will be indicated after 1.5 s?
q = qo [1- exp(1-t/t)]
=100[1- exp(1-1.5 /3.5)] = 34.86°c.
52) A temperature-sensitive transducer is subjected to a sudden temperature change. It takes 10 s for the transducer to reach equilibrium condition (5 times constant). How long will it take for the transducer to read half of the temperature difference?
Time to reach equilibrium conditions = 5t = 10s.
Time constant t= 10/5 =2s.
q = qo [1- exp(1-t/t)]
0.5= 1-[exp(-t / 2)]
t= 1.39s.
53) What is potentiometer?
Basically a resistance potentiometer, or simply a POT, (a resistive potentiometer used for the purposes of voltage division is called a POT) consists of a resistive element provided with a sliding contact.
The POT is a passive transducer.
54) What are the advantages and disadvantages of potentiometer?
Advantages of Potentiometer :
Inexpensive
Useful for measurement of large amplitudes
Efficiency is very high
Frequency response of wire wound potentiometers is limited
Disadvantages of Potentiometer :
Require a large force to move
55) What is gauge factor?
The gauge factor is unit resistance change per unit strain, which is due to three factors as revealed by the above equation.
56) What are the different types of strain gauge?
Unbounded metal strain gauges
Bonded metal wire strain gauges
Bonded metal foil strain gauges
Vacuum deposited thin metal film strain gauges
Sputter deposited thin metal strain gauges
Bonded semiconductor strain gauges
Diffused metal strain gauges.
57) What are the factors to be considered for bonded strain gauge?
Filament construction
Material of the filament wire
Base carrier material or backing material
Cement used to bond the filament to the carrier
Lead wire connections.
58) What is strain?
It is a ratio of changing length to original length.
59) What is young's modulus?
It is a ratio of stress and strain, dR/R / dl/l

60) What are resistance thermometers?
A resistance thermometer consists of a resistive element which is exposed to the temperature to be measured.
If the conductors or metals are used to measure the temperature, they are known as resistance thermometers and if semiconductors are used then they are known as thermistors.
ALSO READ : CONTROL SYSTEMS QUESTIONS & ANSWERS
61) What are the different approximation methods of resistance thermometer?
Linear approximation:
Quadratic approximation
62) What is self-heating error of thermometer?
Resistance thermometer bridges may be excited with either d.c.or a.c .The direct or rms alternating current through the thermometer is usually in the range of 2 to 20 mA.
This current causes an I2R heating which raises the temperature of the thermometer above its surrounding, causing the so called self-heating error.
63) What are the advantages and disadvantages of resistance thermometers (RTD) ?
Advantages of RTD :
They are suitable for measuring large temperature differences and high temperatures.
They are very accurate which makes them suitable for small temperature measurement.
Well-designed resistance thermometers have excellent stability
Unlike thermocouples, they do not need a reference junction and this favors them in many aerospace and industrial applications.
Disadvantages of RTD :
Their relatively large volume compared to thermocouples results in monitoring an average temperature over the length of the resistor rather than a point temperature.
They need auxiliary apparatus and power supply.
The resistance element is usually more expensive than a thermocouple.
There are errors due to self-heating and thermoelectric effect of theresistive element and connecting leads (dissimilar metal junctions).
64) What is the principle of hot wire anemometer?
Othername of resistance variation type transducers is hot wire anemometer. In general anemometers are devices used for measurement of velocity of flow.
65) Why dynamic compensation is required for hot wire anemometer?
It is used avoid the fluctuation, we need dynamic compensation circuits for the hotwire anemometer.
66) What are the applications of thermistors?
Measurement of power at high frequencies
Measurement of thermal conductivity
Measurement of level, flow and pressure of liquids
Measurement of composition of gases
Vacuum measurements
Providing time delay.
67) Mention the features of thermistors.
Compact, rugged and inexpensive
Good stability
The response time of thermistors can vary from a fraction of a second to minute
Self-heating of thermistors is avoided
Thermistors can be installed at a distance from their associated measuring circuit
68) Mention the materials used for thermistors.
Mixture of metallic oxides such as manganese, nickel, cobalt, copper, iron and uranium.
69) Mention the applications of strain gauge.
Used to measure pressure
Used to measure torque
Used to measure acceleration

Used to measure force
70) What is inductance transducer?
Transducers based on the variation of inductance are another group of importance devices used in much application.
In these transducers self-inductance or the mutual of a couple of coils is changed when the quantity to be measured is varied.
71) Mention three principles of inductance transducer.
Change of self-inductance
Change of mutual inductance
Production of eddy currents.
72) What is LVDT?
The Linear Variable Differential Transformer (LVDT) is the most common mutual inductance element.
This can be considered to be a versatile transducer element for most of the electromechanical measuring systems with regards to resolution, hysteresis, dynamic response, temperature characteristics, linearity and life.
73) What are the advantages and disadvantages of LVDT?
Advantages of LVDT :
High range
Friction and electrical Isolation
Immunity from external effects
High input and high sensitivity
Ruggedness
Low hysteresis
Low power consumption
Disadvantages of LVDT :
Relatively large displacements are required for appreciable differential output
They are sensitive to stray magnetic fields but shielding is possible
Many a times, the transducer performance is affected by vibrations
The receiving instrument must be selected to operate on a.c
The dynamic response is limited
Temperature affects the performance of the transducer.
74) What are the applications of LVDT?
Displacement measurement and LVDT Gage heads
LVDT pneumatic servo follower
LVDT Load cells
LVDT Pressure Transducer
75) What is null voltage?
Ideally the output voltage at the null position should be equal to zero. However, in actual practice there exists a small voltage at the null position.
76) Explain the principle of Induction Potentiometer?
The primary is excited with alternating current. This induces a voltage in to the secondary.
The amplitude of this output voltage varies with the mutual inductance between the two coils and this varies with the angle of rotation.
77) Explain the principle of Variable Reluctance Accelerometer?
Another common version of the variable reluctance principle.
This is an accelerometer for measurement of accelerometer for measurement of acceleration in the range ± 4g. Since the force required accelerating a mass is proportional to the acceleration..
78) What is the need of demodulator in Variable Reluctance Accelerometer?
To detect motion on both sides of zero, a fairly involved phase- sensitive demodulator would be required.
To eliminate the demodulator the iron core and springs were adjusted so that core was offset to one side by an amount equal to the spring deflection corresponding to 4 g

acceleration.
79) What is the principle of capacitive transducer?
Many industrial variables like displacement, pressure, level, moisture, thickness etc. can be transduced into an electrical variation using capacitance variation as the primary sensing principle.
80) What are the desirable features of capacitive transducer?
Its force requirements are very small
As the moving plates have very little mass, design of transducer with fast response characteristics is possible
There is no physical between moving and stationary parts
Does not depends the conductivity of the metal electrode
Shielded against the effect of external electric stray fields.
81) What are the different practical capacitance pickups?
Equibar differential pressure transducer
Feedback type capacitance proximity pickup
Condenser microphone.
82) What is Microphone?
It is also a transducer which converts sound energy into electrical energy.
Example is condenser microphone.
83) What is the principle of change of capacitance?
Change in overlapping area A
Change in the distance between the plates d
Change in dielectric constant.
84) What are the advantages of capacitive transducers?
They require only small force to operate
Have a good frequency response
Extremely sensitive
High input impedance
85) What are the disadvantages of capacitive transducers?
The metallic parts of the capacitive transducers must be insulated from each other
Non-linear behavior
This leads loading effects
The cable may be source of loading resulting loss of sensitivity.
86) What are the uses of capacitive transducer?
Can be used for measurement of linear and angular displacement
Can be used for measurement of force and pressure
It can be used as pressure transducer
Measurement of humidity in gases
Commonly used for measurement of level, density, weight.
87) What is the value of capacitance for measurement of level of a non-conducting liquid?
C= 2pe0 [e1 h1 + e2 h2 / loge (r2/r1)]
Where, h1= height of liquid
h2= height of cylinder
e1=relative permittivity of liquid
e2= relative permittivity of vapour above liquid r2= inside radius of outer cylinder
r1= outer radius of inner cylinder
e0= relative permittivity of free space
88) What is analog transducer?
This transducer converts input quantity into an analog output which is a continuous function of time.
Thus a strain gauge, LVDT, thermocouple, thermistors, may be called as analog transducer.
89) What is digital transducer?
These transducer convert input quantity into an electrical output which is in the form of

pulses.
90) What is piezo electric transducer?
They convert pressure or force into electrical charge.
These transducers are based upon the natural phenomenon of certain non-metal and di-electric components.
91) What are the suitable materials for piezo electric transducer?
Primary quartz, Rochelle salt, ammonium di-hydrogen phosphate (ADP), and ceramics with barium titanate, di-potassium tartrate, potassium di-hydrogen phosphate and lithium sulfate.
92) What is'd'coefficient?
Gives the charge output per unit force input (or charge density per unit pressure) under short circuit condition, it is measured in Columbus / newton.
93) What is 'g' coefficient?
G-coefficient representing the generated e.m.f gradient per unit pressure input.
94) What is 'h' coefficient?
It is obtained by multiplying the g-coefficient by young's modulus valid for the appropriate crystal orientation of the material, and thus measures the e.m.f gradient per unit mechanical deformation, or (V/m) / (m/m).
95) What are the suitable materials for magneto-strictive transducer?
Iron , nickel, 68 permalloy and ferroxcube ect .
96) What is magneto-strictive transducer?
The permeability can increase or decrease depending upon the material, type of stress , and the magnetic flux density in the sample.
97) What are the different magneto-strictive transducer?
Magneto-strictive load cell
Magnetostrictive Accelerometer
Magnetostrictive Phonographic Pickup
Magnetostrictive Torque Transducer
98) What are the errors in Magnetostrictive transducer?
Hysteresis
Temperature
Eddy current
Input impedance
99) What are the special features of magneto-strictive transducer?
To measure large force
measure several thousand "g"
Characteristics depend upon temperature.
100) What is fiber optic transducer?
Fiber optic cable consists of outer core and inner cladding.
Data is transmitted in the form of light.It is used for measuring displacement,torsion.
101) Compare digital transducer with analog.
Digital transducer gives digital outputs. Analog transducers outputs are continuous functions of time.
If these analog transducers are to be interfaced with digital devices, then one has to use analog to digital converters.
102) How will u achieve high resolution in digital transducer?
The number of tracks must be increased and the length of each coded should be reduced, which would require fine brushes.
103) What are the different digital transducer are available?
digital displacement transducer
shaft angle encoder
optical encoder
magnetic encoder
104) what is piezo electric effect?
A piezo electric material is one in which an electric potential appears across certain

surfaces of a crystal if the dimensions of the crystal are changed by the application of the mechanical force.

105) What is digitizer?

Digital encoding transducer or digitizer enables a linear or rotary displacement to be directly converted into digital form without intermediate form of analog to digital (A/D) conversion.

106) What are the classifications of encoder?

Tachometer transducer
Incremental transducer
Absolute transducer

107) What are the input characteristics of the transducer?

Type of input and operating range
Loading effect

108) What is zero error of the transducer?

In this case output deviates from the correct value by a constant factor over the entire range of transducer.

109) What are the different transfer characteristics of the transducer?

Transfer function
Error
Scale error
Zero error
Sensitivity error
Non- conformity
Hysteresis
3. Transducer response
