Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

1 Attempt any TEN of the following: **20**

1a) Define accuracy and precision

Ans:

1) **Accuracy:**

It is the closeness of an instrument reading with the true value of the quantity under measurement. **OR** It is defined as the ability of a instrument to respond to a true value of a measured variable under reference conditions.

1 Mark for each definition = 2 Marks

2**) Precision:**

It is measure of the reproducibility of the measurements; i. e. given a fixed value of a quantity, precision is a measure of the degree of agreement within a group of a measurement of the same quantity.

1b) List any four effects employed in measuring instruments.

Ans:

Effects Employed in Measuring Instruments:

1. Magnetic Effect
2. Electromagnetic induction
3. Heating effect
4. Electrostatic effect
5. Hall Effect

½ Mark for each of any four effects = 2 Marks

1c) State working principle of PMMC instrument.

Ans:

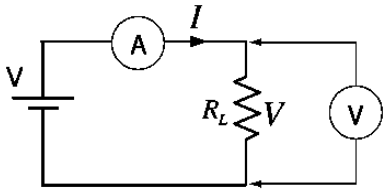
Working Principle of PMMC Instrument:

When current carrying conductor is placed in a constant magnetic field, it experiences a force proportional to the current and produces proportional deflection torque. 2 Marks

1d) Show how ammeter and voltmeter are connected in circuit for measurement of current and voltage.

Ans:

Connection of Ammeter and Voltmeter for Measurement of Current and Voltage in Circuit:



2 Marks

1e) Write any two advantages of MI type instrument.

Ans:

Advantages of MI Type Instrument:

1. These are robust in construction.
2. Used for both A.C. as well as D.C. measurements.
3. These are economical.
4. These possess high operating torque.

1 Mark for each of any two advantages = 2 Marks

5. These are simple in construction hence can be easily handled.

1f) State the material used for moving coil and former for PMMC instruments.

Ans: 1Mark each

Material Used for Moving Coil and Former for PMMC Instruments: = Total

Material used for moving coil: Copper 2 Marks

Material used for Former: Aluminium

1g) List one advantage and one disadvantage of one wattmeter method.

Ans:

Advantages: 1 Mark for each of any one advantages

1) Only one wattmeter is used.
2) Less number of connections.
3) Cost required is less.

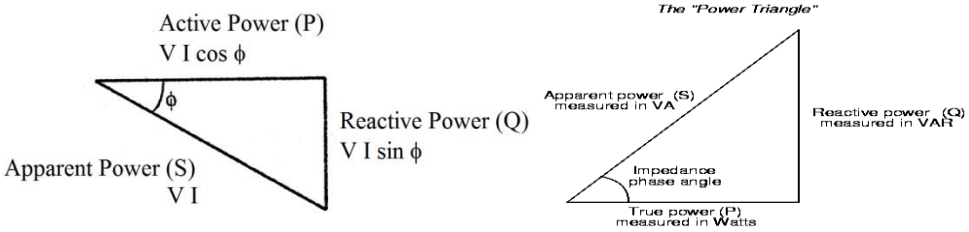
Disadvantages: 1 Mark for each of any one dis-advantages

1) Used only for 3- Φ balanced load and not for unbalanced loads.
2) Star point must be accessible for connecting the Pressure coil.
3) Delta connection must be opened to connect current coil.

1h) Draw power traingle and state all powers.

Ans:

Power Traingle:



1 Mark for diagram

OR

Sides of Triangles / All powers:

1. Active power
2. Reactive power
3. Apparent power

1 Mark

1i) Write any two advantages of digital energy meter.

Ans:

Advantages of Digital Energy Meter:

1) Easy to read.
2) High accuracy
3) High resolution.
4) No frictional losses as there are no moving parts.
5) No requirement for external adujstments.
6) Large frequency range due to absence of moving parts.
7) Highly efficient.
8) Very much compact.
9) Good reliability.

1 Mark for each of any two advantages = 2 Marks

1j) Why energy meter is integrating type measuring instrument?

Ans:

Energy Meter is Integrating Type Measuring Instrument:

Energy meter is used for measurement of energy, which is obtained by integration (summation) of power supplied over the particular time duration, hence it the integrating type measuring instrument. — 2 Marks

1k) Find multiplying factor of 10A/300V for unity P.F with having FSD =1500W.

Ans:

Multiplying Factor:

Multiplying Factor is used for calculating the final value of wattmeter reading. Its value is calculated by

$$\text{Multiplying factor} = \frac{Voltage\ Range \times Current\ Range \times PF}{FSD}$$

$$\text{Multiplying factor} = \frac{300 \times 10 \times 1}{1500} = 2$$

2 Marks

1l) Give classification of resistance based on their ranges.

Ans:

Classification of Resistances Based on Their Ranges:

1) Low resistance: less than 1 ohm.
2) Medium resistance: 1 ohm to 0.1 Mega ohms.
3) High resistance: greater than 0.1 Mega ohms.

2 Marks

2 Attempt any <u>FOUR</u> of the following: **16**

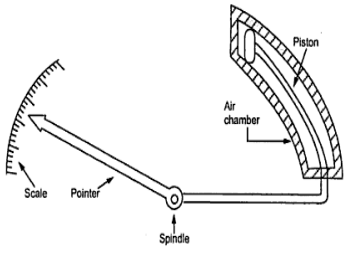
2a) Describe with neat diagram air friction damping.

Ans:

Air Friction Damping:

Here air trapped in the chamber works as damping medium for the piston movement connected to the spindle. The piston moves in the air chamber. The clearance between piston and air chamber wall is very small. When the pointer system moves in either direction, the piston arm experiences an opposing force due to either compression action on one side and opposition to expansion on the other side. Thus the oscillations of the pointer system are damped by the opposition by the damping system. The damping torque is directly proportional to the speed at which the piston (pointer/spindle) moves. Hence greater the speed, higher will be the damping torque, bringing the pointer to the equilibrium position quickly.

2 Marks for explanation



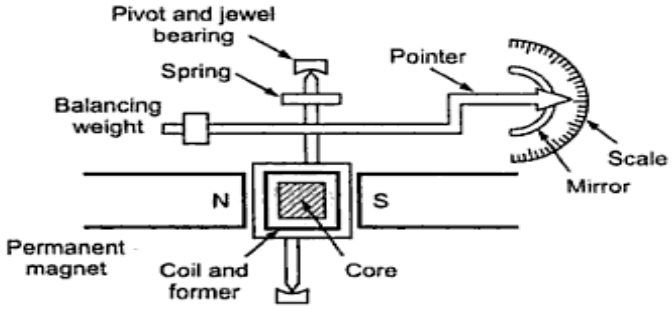
Air friction damping

2 Marks for diagram

2b) Draw a neat labeled diagram of PMMC instruments.

Ans:

PMMC type instrument:



Or Equivalent figure

4 Marks for labeled diagram
3 Marks for partially-labeled diagram
2 Marks for unlabeled diagram

2c) How range of A.C. ammeter & A.C. voltmeter is extended? Draw suitable diagram.

Ans:

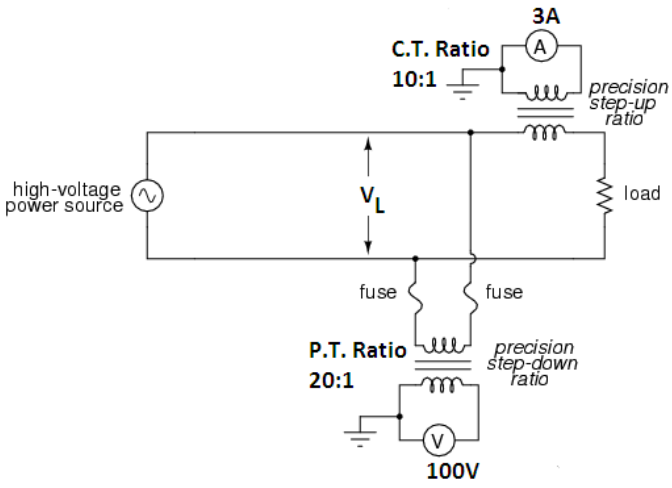
Extension of A.C. Ammeter Range:

The range of a.c. ammeter can be extended by using CT, the arrangement is shown in figure. The CT is current transformer having less number of primary turns carrying high magnitude of line current and more number of secondary turns hence reducing the secondary current as per its CT ratio. The low range ammeter can be connected in secondary circuit for measurement of reduced line current, which indirectly measure high magnitude of line current. In this way range of a.c. ammeter can be extended.

2 Marks for explanation

Extension of A.C. Voltmeter Range:

The range of a.c. voltmeter can be extended by using PT, the arrangement is shown in figure. The PT is potential transformer having more number of primary turns connected to the high voltage source and less number of secondary turns hence reducing the secondary voltage as per its PT ratio. The low range voltmeter can be connected to secondary for measurement of reduced source voltage, which indirectly measure high magnitude of source voltage. In this way range of a.c. voltmeter can be extended.

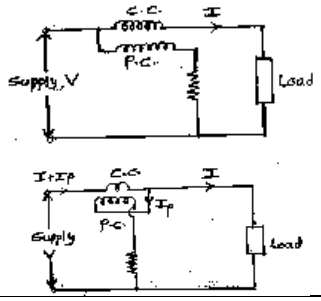


2 Marks for diagram

2d) List the different errors in wattmeter & explain compensation for it.

Ans:

Different Errors in Wattmeter With their Compensation:

Sr. No.	Errors in Wattmeter	Compensation method
1	Error due to connection method 	To overcome this error, wattmeters are provided with additional compensating winding which is connected in series with pressure coil but positioned in such a manner that it produces a field in opposition to that produced by current in current coil.
2	Error due to pressure coil inductance	A suitable value capacitor connected in parallel with pressure coil.
3	Error due to Pressure Coil Capacitance	This error can be reduced by designing pressure coil circuit such that inductive reactance of the circuit matches exactly with the capacitance reactance of the circuit i.e. $X_L=X_C$.
4	Error due to mutual inductance effect	This error can be reduced by proper design of pressure coil and current coil system so that they always remain in a zero position of mutual inductance.
5	Error due to stray magnetic fields	To avoid this error, magnetic shield is placed over CC & PC.
6	Error due to eddy currents	These are minimized by avoiding solid metal parts and using laminated core.
7	Temperature error	Using zero temperature coefficient materials for coils and components, this can be minimised.
8	Error due to vibration of moving system	It is avoided by designing the moving system such that its natural freq is greater than 2 times the freq of deflecting torque of the wattmeter.
9	Error due to friction	The weight of moving system be reduced to minimum possible.

1 Mark for each of any four points = 4 Marks

2e) Explain construction & working of electrodynamometer type wattmeter.

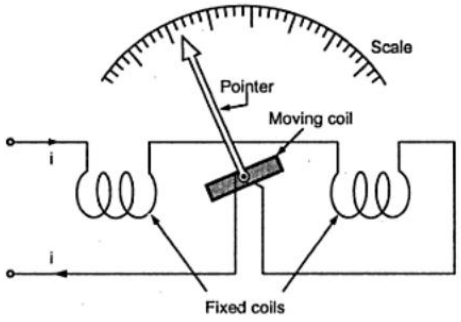
Ans:

Electrodynamometer Type Wattmeter:

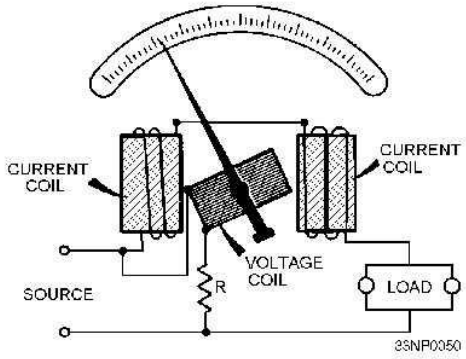
Construction:

It essentially consists of the fixed and moving coil. The fixed coil is split into two equal parts which are placed close together and parallel to each other. Moving coil is pivoted in between

two fixed coils.The fixed and moving coils are exited / connected as shown in figure. The moving coil is attached to the moving system so that under the action of deflecting torque the pointer moves over the scale. Controlling torque is provided by springs and damping torque is provided by air friction damping.



OR



2 Marks for construction

Working:
When the instrument is connected in the circuit operating current flow through the coils due to this mechanical force exists between the coils. The result is that moving coil moves the pointer over the scale to give reading. When direction of current reverses, then it reverses the direction of current of fixed as well as moving coil so that the direction of deflecting torque remains unchanged hence these instruments can be used for measurement of A.C. & D.C. power.

2 Marks for working

2f) Compare analog & digital multimeter.(any 4 points)
Ans:

Analog multimeter	Digital multimeter
1. Power supply is not required	1. Power supply is required
2. Less suffered from electric noise	2. Suffered from electric noise.
3. It provides measurement in analog form with metal pointer.	3. It provides measurement in digital form using digits as per resolution needed.
4.It uses simple display with markings for various ranges as per R, V and I measurements.	4. It uses LCD display.
5. It does not require ADC converter i.e. analog to digital converter	5. It requires ADC converter and quantity to be displayed is in digital form.
6. Accuracy of measurement is lower	6. Accuracy of measurement is higher
7. Input resistance vary as per range to be measured.	7. Input resistance is constant for all ranges.
8. Simple & rugged in construction	8. Complicated & delicate in construction
9. Bigger in size	9. Compact in size
10. Economical	10.Expensive

1 Mark for each of any four points = 4 Marks

3 Attempt any FOUR of the following: **16**

3a) A moving coil instrument with full scale deflection of 100mA & internal resistance of 20Ω.calculate the value of shunt required to be connected in parallel to measure current of 20A

& value of multiplier required to measure voltage of 400V.

Ans:

Given: Full scale deflection current I_G = 100 mA .

Resistance of moving coil instrument R_G = 20 Ω.

Shunt resistance R_{sh} :

For full scale deflection when the arrangement carries current of I = 20 A, using the principle of equal voltage across parallel resistances of R_G and R_{sh},

$I_G.R_G = (I - I_G) R_{sh}$ 2 Marks

$R_{sh} = I_G.R_G/(I - I_G) = 100 \times 10^{-3} \times 20/(20 - 100 \times 10^{-3})$

= 0.1005 ohm

∴ Shunt resistance for using instrument as an ammeter to read 10A,

R_{sh}= 0.1005 Ω

Series Resistance R_{se}:

With (V_M = 400 V) applied to the series combination of moving coil and the series resistance R_{se} ,to use it as voltmeter to read 400 V, the max current allowed is 100 mA.

$400 = 100 \times 10^{-3} \times (R_{se} + R_G)$

$R_{se} = 4000 - R_G = 4000 - 20 = 3980$ ohm 2 Marks

∴ Series resistance for using instrument as a voltmeter to read max 500V,

R_{se}= 3980 Ω

3b) Explain magnetic effect & heating effect of electric current.

Ans:

Effects of Electric Current:

1. **Magnetic Effect:**
   When a current is passed through a conductor, magnetic field is produced round the conductor. Due to this field when current carrying conductor is placed in a magnetic field it experiences a mechanical force. 2 Marks
   When we bring one permanent magnet near to another electromagnet then there is a force of attraction or repulsion depending on the direction of current in the coil of electromagnet.
2. **Heating effect:**
   When current is passed in the conductor, heat is produced which is proportional to I^2Rt , where I is current flowing in conductor, R is resistance of conductor and t is time duration of current flow. 2 Marks
   The current to be measured is passed through a small element which heats due I^2Rt power loss. The rise in temperature is converted into elongation of hot wire element causes displacement of pointer.

3c) Discribe procedure for calibration of ammeter with diagram.

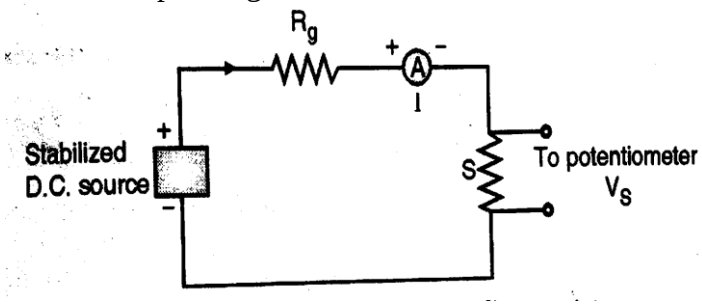
Ans:

Procedure for Calibration of Ammeter:

In this method, DC potentiometer is used for measurement of voltage across a standard low resistance. 2 Marks for explanation

- Connect the circuit as shown in the figure, the ammeter to be calibrated is connected in series with standard resistance and regulating resistace Rg.
- By varying Rg, voltage across potentiometer (S) is measured. Before measurement

potentiometer is required to be standardized. At the same time current through ammeter is also measured (I). i.e. reading of ammeter under calibration.
The sub-standard or calibrated meter and meter under test are connected in series and readings are noted for corresponding currents.



2 Marks for diagram

- At each step, true value of ammeter is calculated as,
  where, Vs = Voltage across potentiometer
  S = resistance of potentiometer
- And the currents are compared for finding out error in ammeter.

OR Equivalent procedure

3d) Define active power, reactive power & apparent power .Also write unit of them.
Ans:

(i) Active Power:
Active power (P) is the product of voltage, current and the cosine of the phase angle between voltage and current.
Unit: watt (W) or kilo-watt (kW) or Mega-watt (MW)

$$P = VI\cos\emptyset = I^2R \text{ watt}$$

(ii) Reactive Power:
Reactive power (Q) is the product of voltage, current and the sine of the phase angle between voltage and current.
Unit: volt-ampere-reactive (VAr), or kilo-volt-ampere-reactive (kVAr) or Mega-volt-ampere-reactive (MVAr)

$$Q = VI\sin\emptyset = I^2X \text{ volt-amp-reactive}$$

4 Marks

(iii) Apparent Power (S):
This is simply the product of RMS voltage and RMS current.
Unit: volt-ampere (VA) or kilo-volt-ampere (kVA)
or Mega-vol-ampere (MVA)

$$S = VI = I^2Z \text{ volt-amp}$$

3e) Define power factor. Draw neat diagram for 1 phase dynamometer type power factor meter.
Ans:
Power Factor:
It is the cosine of the angle between the applied voltage and the resulting current.
Power factor = $\cos\phi$
where, ϕ is the phase angle between applied voltage and current.

OR

It is the ratio of true or effective or real power to the apparent power.

$$\text{Power factor} = \frac{\text{True Or Effective Or Real Power}}{\text{Apparent Power}} = \frac{VI\cos\emptyset}{VI} = \cos\emptyset$$

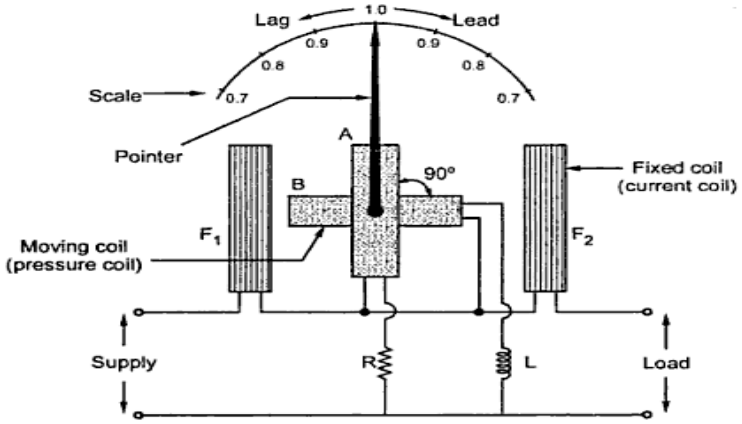
1 Mark

OR

It is the ratio of circuit resistance to the circuit impedance.

Power factor $= \frac{\text{Circuit Resistance}}{\text{Circuit Impedance}} = \frac{R}{Z} = \cos\emptyset$

Single-Phase Dynamometer Type Power Factor Meter:



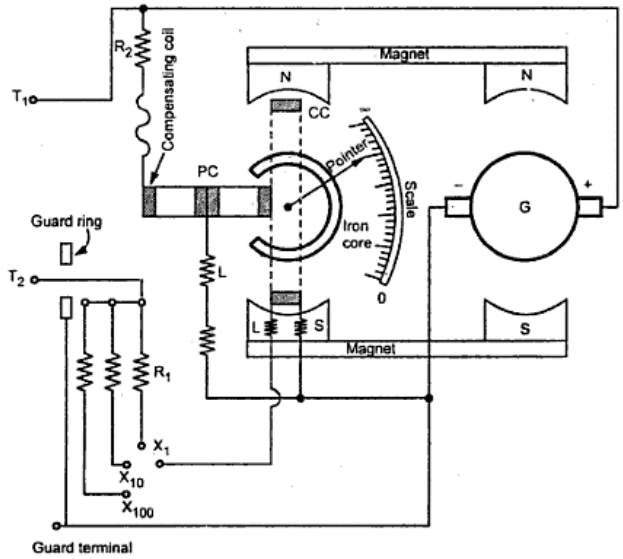
Single phase electrodynamometer type power factor meter

3 Marks

3f) Draw neat labelled sketch of Megger .

Ans:

Megger:



Labeled diagram 4 Marks

Partially Labeled diagram 3 Marks

Unlabeled diagram 2 Marks

OR Equivalent sketch

4 Attempt any FOUR of the following: 16

4a) Explain spring control method with neat diagram.

Ans:

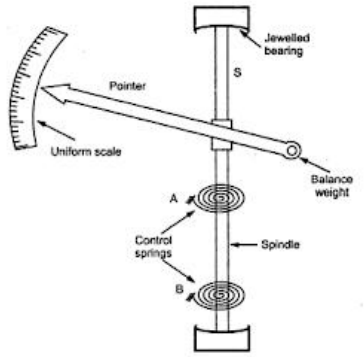
Spring Control Method:

As shown in the figure the inner ends of the both springs are attahced to the spindle ,while outer end of upper spring is attached to the lever and outer end of the lower spring is fixed.

With the defection of the pointer the springs are twisted in opposite direction to the motion of

2 Marks for

pointer and produce controlling torque. explanation



2 Marks for diagram

4b) Compare PMMC & MI instrument.

Ans:

Comparison Between PMMC & MI Instrument:

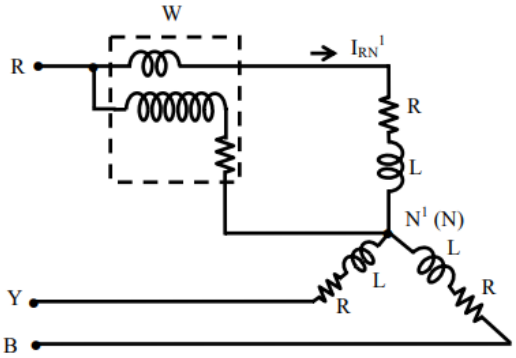
Points	PMMC instruments	MI instruments
Principle	When current carrying conductor is placed in a magnetic field, it experiences mechanical force	Piece of iron is attracted /repelled by magnet or magnetic field.
Scale	Uniform	Non-uniform
Torque/Weight ratio	Higher	Lower
Application	PMMC instruments are used only for DC measurements	Used for DC as well as AC measurements
Cost	Higher cost for same range	Lower cost for same range
Damping	Eddy current	Air friction
Sensitivity	More sensitive	Comparatively less sensitive

1 Mark for each of any four points = 4 Marks

4 c) Draw circuit diagram for 3ϕ active & reactive power measurement using one wattmeter.

Ans:

Circuit Diagram for 3-ϕ Active Power Measurement Using One Wattmeter:

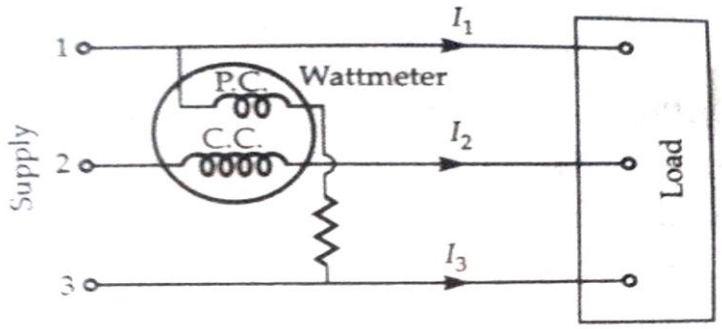


2 Marks

OR Equivalent circuit

Circuit Diagram for 3-ϕ Reactive Power Measurement Using One Wattmeter:

2 Marks



OR Equivalent circuit

4 d) Explain effect of load P.F. on reading of wattmeters in two wattmeter method.

Ans:

Effect of Load P.F. on Reading of Wattmeters in Two Wattmeter Method:

In two wattmeter method the readings of two wattmeters are given by equations:

$W_1=V\ I\cos(30+ø)$ and $W_2=V\ I\cos(30-ø)$

We will consider different cases of power factors

1. If power factor is unity i.e. p.f.=1 ($ø=0^0$)
   $W_1=V\ I\cos(30+0)$ and $W_2=V\ I\cos(30-0)$
   $W_1=V\ I\cos 30$ and also $W_2=V\ I\cos 30$
   Thus both the watt meters read equal readings.
2. If power factor is 0.5 lagging i.e.$ø=60^0$
   $W_1=V\ I\cos(30+60)$ and $W_2=V\ I\cos(30-60)$
   $W_1=V\ I\cos 90$ and $W_2=V\ I\cos(-30)$
   $W_1=V\ I(0)$ and $W_2=V\ I\cos(-30)$
   $W_1=0$ and $W_2=V\ I\cos(-30)$
   Thus it is observed that one of the wattmeter reads zero and all the power is measured by second wattmeter.
3. If power factor is between 0.5 and 0. i.e. is greater than 60^0 & less than 90^0. In this case one of the wattmeter gives positive reading and second wattmeter give negative reading. Hence for taking reading of second wattmeter its pressure coil connections or current coil connections is to be interchanged**.**
4. If power factor is 0 i.e. $ø=90^0$
   $W_1=V\ I\cos(30+90)$ and $W_2=V\ I\cos(30-90)$
   $W_1=V\ I\cos 120$ and $W_2=V\ I\cos(-60)$
   $W_1=0.5*V\ I$ and $W_2=V\ I*(-0.5)$
   Thus it is observed that both the wattmeter reads equal and opposite power.
   For leading power factors: - The readings of two watt meters only interchange.

Four cases with effect 1 Mark each = 4 Marks

4e) List any four errors in induction type energy meter. Give method of compensation for each.

Ans:

Errors in Induction Type Energy Meter with their Compensation:

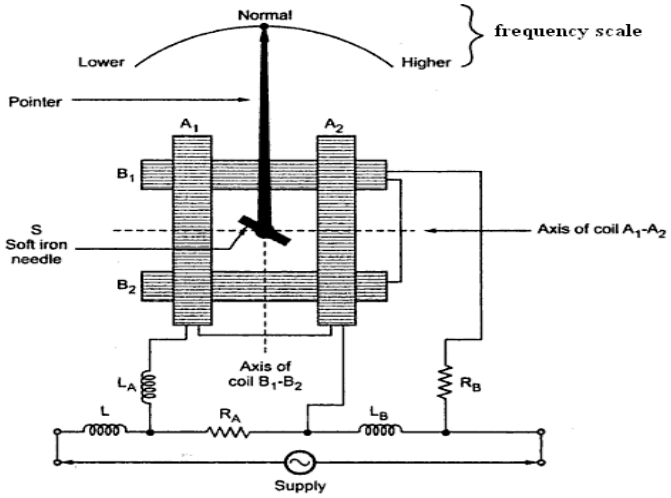
1) **Error due to friction:** This error can be compensated by the additional shading band provided on the shunt electromagnet.
2) **Phase or low p.f. error:**To overcome this error the shading band is provided on the cetral limb of the shunt electromagnet.
3) **Error due to temprature variation:** The effects of temprature changes on the driving and braking system tend to balance each other, hence no need of compensation.
4) **Error due to variation of frequncy:** The frequency should be kept constant.
5) **Creeping error:** This error can be compensted by providing two small holes on the disc diametrically opposite side.When the hole comes under the pole of a shunt magnet,the disc stops running.
6) **Error in Registration:** This error can be compensted by adusting the braking magnet or changing registering system.
7) **Speed error:** This error can be compensted by readusting the compensating mechanism.
8) **Overload error:** This error can be compensated by providing a 'flux diverter' to the current magnet.

1 Mark for each of any four errors = 4 Marks

4f) Explain working of Weston type frequency meter.

Ans:

Working of Weston Type Frequency Meter:



2 Marks for diagram

The mounting and connections are shown in the figure. Inductor L damps the harmonics in the current. When connected across the supply, coils A and B draw currents to produce magnetic fields that act on the soft iron needle to deflect it. The position of the needle depends on these currents. Under normal frequency (due to proper selection of R_A, R_B, L_A, $L_{B,}$) two forces make the pointer to show normal frequency. When the frequency is other than normal, the reactances of L_A and L_B will be different with resistances unchanged, leading to deflections in either direction depending on the currents there in, due to changed impedances.

2 Marks for explanation

5 Attempt any FOUR of the following: 16

5a) Write difference between absolute & secondary instrument.(Any four points)

Ans:

Difference Between Absolute & Secondary Instrument:

Absolute Instrument	Secondary Instrument
1. These give magnitude of quantity in terms physical constants of instruments.	1. These give reading directly of the quantity at the time of measurement.
2. Calibration is not required.	2. Calibration with absolute instruments is required time to time as per requirements.
3. Measurement is time consuming as of tedious calculations.	3. Measurement is quick because of direct measurement.
4. Very rarely used in practical applications.	4. Very widely used in practical applications.
5. Absolute instruments are used in laboratories as standardizing instruments.	5. Secondary instruments are used in everyday work.
6. Examples – Tangent Galvanometer, Absolute electrometer, and Raleigh current balance.	6. Examples – ammeter, voltmeter, ampere-hour meter, wattmeter etc.

1 Mark for each of any four differences = 4 Marks

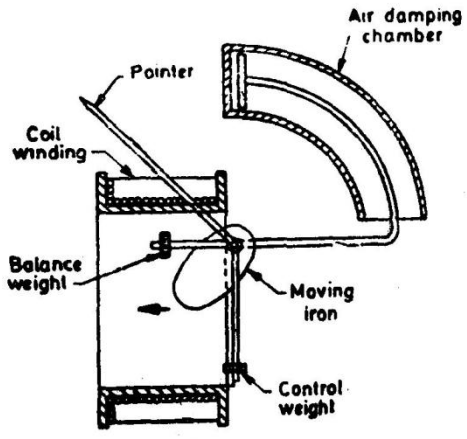
5b) Explain construction & working of attraction type M.I. instrument with neat diagram.

Ans:

Construction & Working of Attraction Type M.I. Instrument:

Construction:

It consists of a coil which is mounted vertically near the spindle carrying an oval shaped soft iron disc, called moving iron. The spindle also carries pointer, balance and control weights, air-damping vane etc. as shown in figure. 1 Mark



Attraction type MI Instrument

1 Mark

Working:

When the instrument is connected in circuit, an operating current flows through the coil, this current sets up magnetic field and ovel shaped moving iron is so magnetized that force is exerted on it by which it moves from the weaker field outside the coil to the stronger field inside the coil or in other words the moving iron is attracted in, resulting the movement of pointer on the scale from zero position to give the reading.The controlling torque is provided

2 Marks

by spring and damping torque is provided by air friction damping with the help of light aluminium piston. Whatever may be the direction of current, the moving iron is always attracted inside the coil, making the instrument suitable for measurement of both DC as well as AC quantities. The force of attraction is proportional to the square of current in the coil.

5c) Two wattmeters are connected in circuit for measurement of 3-ϕ power. One wattmeter reads 2500 W & other reads 1500 W. Find P. F. of circuit when
(i) Both readings are positive.
(ii) When reading of 1500 W is obtained after reversing current coil of wattmeter.

Ans:

Assuming W_1 = 2500 W and W_2 = 1500W

i) When Both Wattmeter Readings are Positive:

$$\text{Pf} = \cos\emptyset = \cos\left[\tan^{-1}\frac{\sqrt{3}(W1-W2)}{(W1+W2)}\right]$$

$$\cos\left[\tan^{-1}\frac{\sqrt{3}(2500-1500)}{(2500+1500)}\right] = \text{Cos } 23.412 = 0.917$$

2 Marks

ii) When Reading of 1500 W is Obtained After Reversing Current Coil of Wattmeter:

$$\text{Pf} = \cos\emptyset = \cos\left[\tan^{-1}\frac{\sqrt{3}(W1-W2)}{(W1+W2)}\right]$$

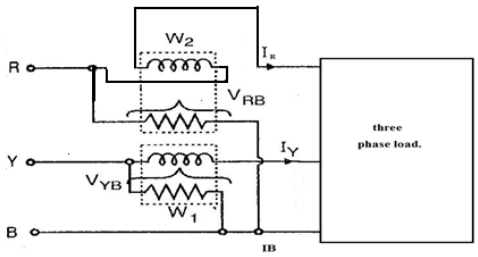
$$\cos\left[\tan^{-1}\frac{\sqrt{3}(2500-(-1500))}{(2500-1500)}\right] = \text{Cos } 81.786 = 0.142$$

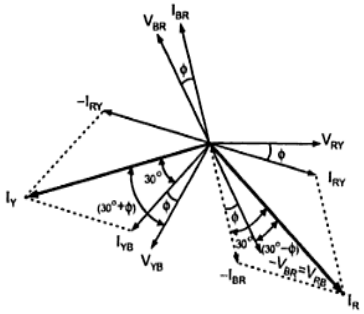
2 Marks

5d) Explain with neat diagram power measurement using two wattmeter method.

Ans:

Power Measurement Using Two Wattmeter Method:





$\hat{I_R V_{RB}} = \hat{I_R}(-V_{BR}) = 30 - \phi$

$\hat{I_Y V_{YB}} = 30 + \phi$

2 Marks for both diagrams

Consider two wattmeters W_1 and W_2 used for measurement of power in three phase balanced load as shown in figure with its phasor diagram**.**

Here,

$V_L = V_{RB} = V_{YB}$, $I_L = I_R = I_Y$

Ø = phase angle between voltage and current of the phases

Reading $W_1 = V_{RB}\ I_R\ \cos(30° - Ø)$

$= V_L\ I_L \cos(30° - Ø)$

& $W_2 = V_{YB}\ I_Y\ \cos(30° + Ø)$

$= V_L\ I_L \cos(30° + Ø)$

$\therefore W_1 + W_2 = V_L\ I_L \{\cos(30° - Ø) + \cos(30° + Ø)\}$

$= V_L\ I_L \{\cos30°\cos Ø + \sin30°\sin Ø + \cos30°\cos Ø - \sin30°\sin Ø\}$

$= V_L\ I_L \{2\cos30°\cos Ø\}$

2 Marks for derivation

$= V_L I_L \{2 (\sqrt{3}/2)\cos Ø \}$

$\therefore W_1 + W_2 = \sqrt{3} V_L I_L \cos Ø$

$\therefore$ Total active power $P = (W_1 + W_2) = \sqrt{3} V_L I_L \cos Ø$

Now $W_1 - W_2 = V_L I_L \{ \cos(30° - Ø) - \cos(30° + Ø)\}$

$= V_L I_L \{(\cos30°\cos Ø + \sin30°\sin Ø) – (\cos30°\cos Ø - \sin30°\sin Ø)\}$

$= V_L I_L \{\cos30°\cos Ø + \sin30°\sin Ø – \cos30°\cos Ø + \sin30°\sin Ø\}$

$= V_L I_L \{2 \sin30°\sin Ø \}$

$= V_L I_L \{2 (0.5)\sin Ø \}$

$= V_L I_L \sin Ø$

Since total 3-ph reactive power $= \sqrt{3} V_L I_L \sin Ø$

Total reactive power $Q = \sqrt{3}(W_1 - W_2) = \sqrt{3} V_L I_L \sin Ø$

OR Equivalent method.

5e) State the application of phase sequence indicator; clip on ammeter, frequency meter & P.F. meter.

Ans:

Phase Sequence Indicator:

1. For finding correct phase sequence of supply
2. For obtaining exact instant of parallel operation of alternators.
3. For obtaining reversal of rotation of A.C. motors

Clip on Ammeter:

4. Measurement of leakage current at grounded conductors
5. Measurement of leakage current at single-phase or 3-phase systems
6. Measurement of line current in live situations
7. Measurement of charging current

Frequency Meter:

1. Measurement of supply frequency
2. For obtaining exact instant of parallel operation of alternators
3. For obtaining exact instant of parallel operation of transformers
4. AC motor tuning
5. Audio frequency pitch tuning
6. RF signal calibration
7. Parasitic harmonics and cross-modulation detection within RF signals
8. Heavy equipment vibration monitoring

P.F. Meter:

1. For obtaining power factor of the load
2. On the distribution panels
3. For electrical load monitoring
4. In electroplating industries
5. In various processes industries for measuring power factor

1 Mark for each of any one valid application

5f) Explain with neat diagram Weston type frequency meter.

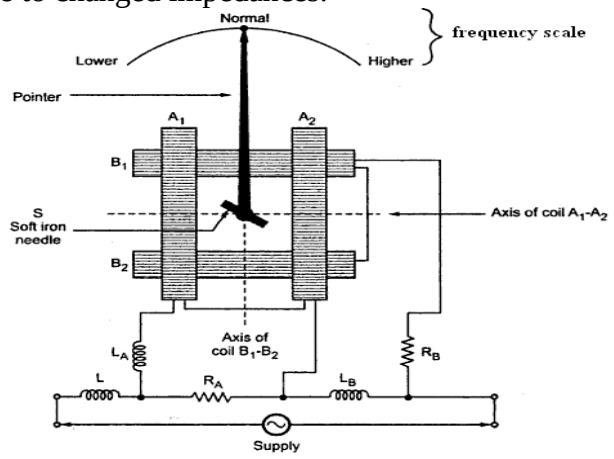
Ans:

Weston Type Frequency Meter:

There are two fixed coils marked as A and B. Each coil divided into two equal parts and are fixed such that their magnetic axis are perpendicular to each other. At their center a soft iron needle is placed on spindle to which the pointer is attached. The mounting and connections are

shown in the figure. Inductor L damps the harmonics in the current. When connected across the supply, coils A and B draw currents to produce magnetic fields that act on the soft iron needle to deflect it. The position of the needle depends on these currents. Under normal frequency (due to proper selection of R_A, R_B, L_A, $L_{B,}$) two forces make the pointer to show normal frequency. When the frequency is other than normal, the reactances of L_A and L_B will be different with resistances unchanged, leading to deflections in either direction depending on the currents there in, due to changed impedances.

2 Marks for explanation



2 Marks for diagram

6 Attempt any FOUR of the following: 16

6a) State the function of controlling torque. Write two types of it.

Ans:

Function of Controlling Torque:

- To restrict the motion of pointer / spindle and stop the pointer at the relevant position to get correct reading.
- To bring back pointer to zero position when the quantity under measurement is removed.

2 Marks

Types of Controlling Torque:

1. Spring control method
2. Gravity control method

2 Marks

6b) With neat diagram explain calibration of energy meter by direct loading method.

Ans:

Calibration of Energy Meter by Direct Loading Method:

There are three methods for testing/calibration:

1. Long period dial test
2. Using rotary sub- standard meter
3. Using precision grade instruments

All above methods uses connection of energy meter under test in parallel with rotary substandard meter or precision grade meter.

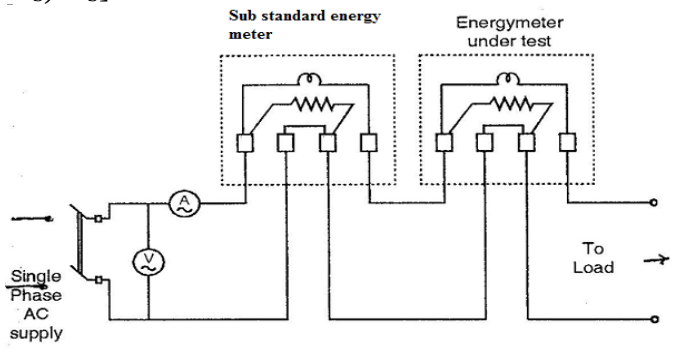
2 Marks for explanation

As in figure the current coils are connected in series hence both the instruments carry same currents and pressure coils are connected in parallel so that same voltage is applied across them. The meters are started and stopped at the same time. The energy readings at the end are compared and error can be calculated and meter is corrected.

Let D = registration of meter under test in kWh &

Ds = registration of substandard meter in kWh

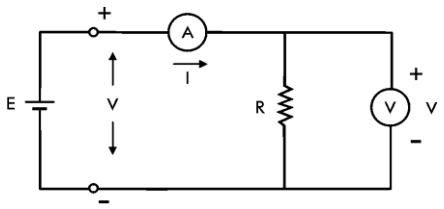
Then % error = $[(D - D_S)/D_S] \times 100$



Calibration of energymeter

2 Marks for diagram

6c) Explain V- I method of measurement of medium resistance.
Ans:

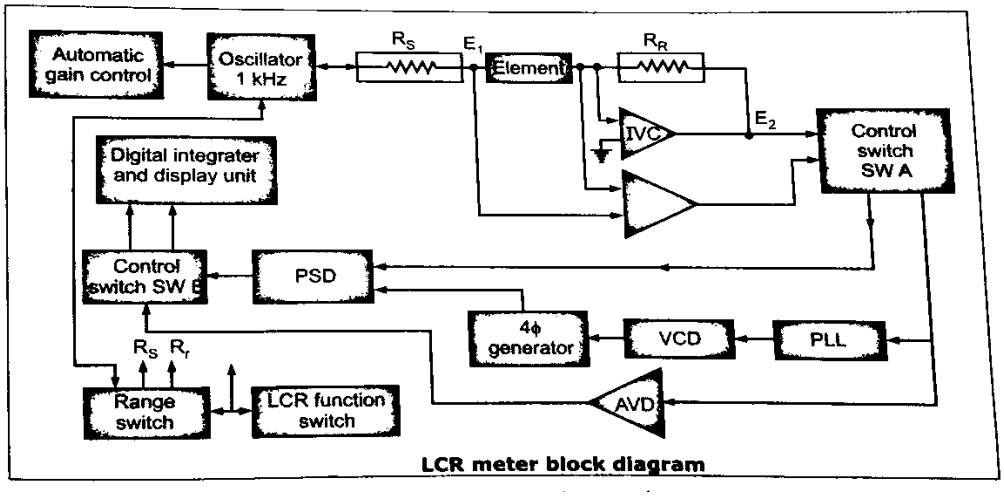


2 Marks for circuit diagram

In this method, use suitable source, ammeter and voltmeter and connect them as shown in the above diagram.
Take reading of voltmeter and ammeter, then value of resistance = R = V/I Ω
To minimise the error take 4 to 5 observation for the same resistance and take their average.

2 Marks for explanation

6d) Draw a neat lablled diagram of LCR meter.
Ans:
LCR meter:



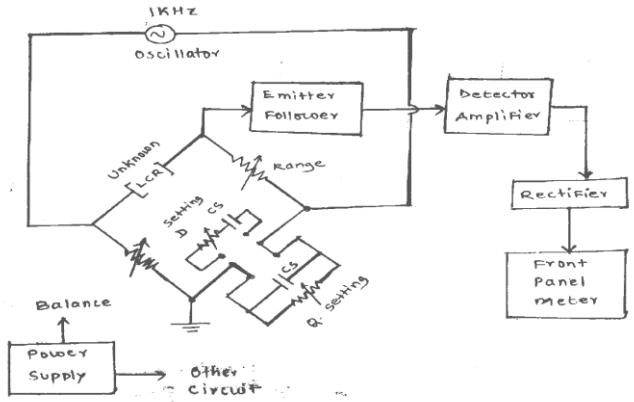
LCR meter block diagram

Labeled diagram 4 Marks

Partially Labeled diagram 3 Marks

Unlabeled diagram 2 Marks

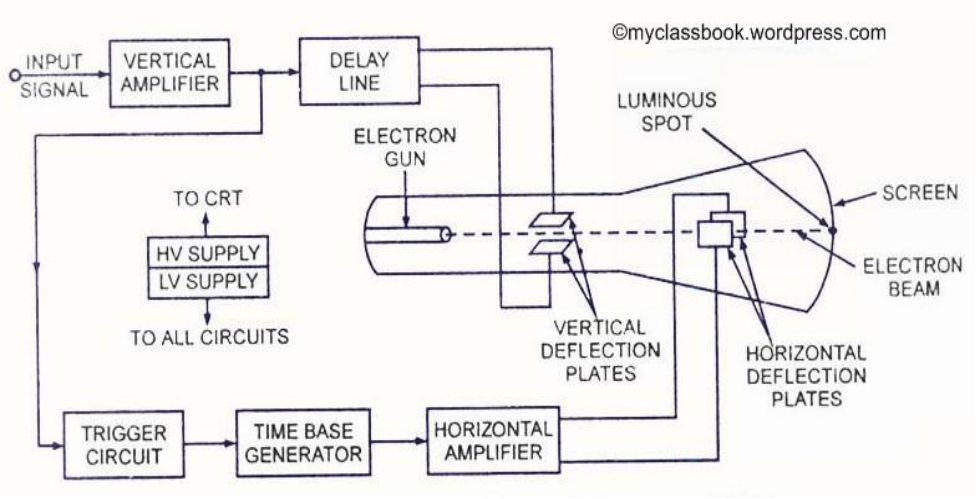
OR



6e) Draw block diagram of CRO. Write function of each block.

Ans:

Block Diagram of CRO With Function of Each Block:



2 Marks for diagram

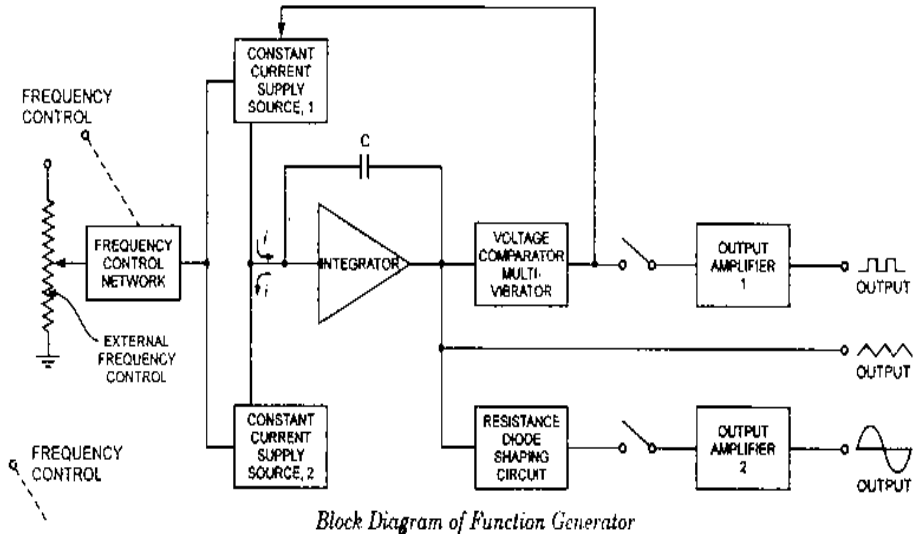
1. Vertical amplifier strengthens the input signal applied to vertical depleting plates
2. Trigger circuit gives input to time base circuit
3. The output of time base generator is amplified by horizontal amplifier and then applied to horizontal deflecting plates of CRT
4. CRT consists of electron gun assembly which include thermally heated cathode, accelerating anode, focusing anode
5. The electron beam coming out from electron gun assembly enters to deflecting plates.
6. The screen of CRT internally coated with Phosphors material on which we observe waveform of the input signal.

2 Marks for explanation

6f) Draw block diagram of function generator. Write applications of function generator.

Ans:

Block Diagram of Function Generator:



Block Diagram of Function Generator

2 Marks for block-diagram

Applications of Function Generator:

1. To test the bandwidth of audio frequency amplifier
2. It can produce sine wave, triangle wave, saw tooth wave, even arbitrary waveform.
3. Function generator has a very wide frequency range, it is an indispensable universal signal source
4. Function generators can be used for production, testing, equipment maintenance and laboratory testing
5. It is also widely used in other areas of science and technology, such as medicine, education, chemistry, communication, earth physics, industrial control, military and aerospace etc.
6. Used for troubleshooting of different analog and digital circuits
7. Acts as source for alignment of receivers.

2 Marks for each of any two valid applications