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 judgment 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

1 a) List any four errors in analog measuring instruments.

1 a) **Ans:**
a)Gross Error
b) Systematic Error:
i) Instrumental Error:
a) Due to inherent shortcomings in the instrument.
b) Due to mis-use of instruments
c) Due to loading effects of instruments
ii) Environmental Error: Errors due to conditions external to the instrument.
iii) Observational Error: Parallax errors.
c) Random Error

Any four errors ½ mark each

1 b) Give two methods of producing control torque in measuring instruments.

1 b) **Ans:**
Two methods of producing control torque:
i) Spring control 1 mark
ii) Gravity control. 1 mark

1 c) State the material used for moving coil and former for PMMC instrument.

1 c) **Ans:**
Material used for moving coil: Copper
Material used for Former: Aluminium

1 mark each

1 d) Name the meter used for measurement of-
i) Direct current ii) Alternating current.

1 d) **Ans:**
Meter used for measurements of-
i) Direct current: PMMC type or M I type ammeter 1 mark
ii) Alternating current: M I type, Induction type, Dynamometer type ammeter 1 mark

1 e) Write any two causes of errors in C. T.

1 e) **Ans:**
Causes of errors in C. T.:
1) There is some exciting mmf required by the primary winding to produce flux and therefore CT draws a magnetizing current.
2) The CT takes loss component of current to supply the core losses (eddy current and hysteresis losses).
3) The flux density in the core is not a linear function of the magnetizing force.
4) There is always a magnetic leakage and consequently the primary flux linkages are not equal to the secondary flux linkages.

1 mark for each of any two.

1 f) State function of current coil in wattmeter.

1 f) **Ans:**

Function of current coil in wattmeter: To produce flux proportional to current in the current coil of wattmeter, this then interacts with the other flux produced by pressure coil to produce torque proportional to power. — 2 marks

1 g) List one advantage and one disadvantage of one wattmeter method for 3-Φ power measurement.

1 g) **Ans:**

Advantages: — Any one Advantage 1 mark

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

Disadvantages: — Any one disadvantage 1 mark

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.

1 h) State the function of brake magnet used in energy meter.

1 h) **Ans:**

Function of Braking magnet: To produce the braking torque for controlling the speed of the aluminum disc. — 2 marks

1 i) Name any two methods for measurement of high resistance.

1 i) **Ans:**

Methods of measurement of high resistance: — Two methods 1 mark each

1) Direct deflection method.
2) Loss of charge method.
3) Mega-ohm Bridge.
4) Using Megger.

1 j) Write two advantages of digital multi-meter over analog multi-meter.

1 j) **Ans:**

Advantages: — 1 mark each any two = 2 marks

1) Easy to read.
2) High accuracy, High resolution and precision.
3) No frictional losses as there are no moving parts.
4) No external adujstments.
5) Large frequency range due to absence of moving parts.
6) Compact and portable.

1 k) State the use of phase sequence indicator.

1 k) **Ans:**

Phase sequence indicator is used to identify the sequence of phases in 3 phase A. C. supply. i. e. R Y B or R B Y. — 2 marks

1 l) Write only the function of storage oscilloscope.

1 l) **Ans:**
Function of storage oscilloscope: Storage oscilloscopes can be used for capturing transient signals, storing it and display it as & when required in future. 2 marks

2 Attempt any FOUR of the following: 16

2 a) List any four effects of electricity employed in measuring instrument. Indentify one instrument for each effect.

2 a) **Ans:**
Effects of Electric Current:

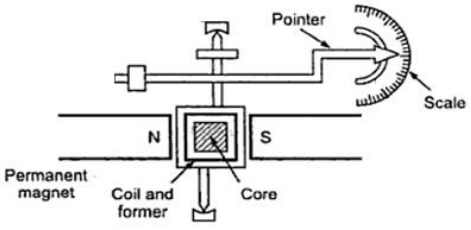
1. Magnetic Effect: PMMC type instrument, Moving Iron type instrument
2. Electromagnetic induction effect: Induction type Ammeters, voltmeters, wattmeters, energy meters etc.
3. Heating effect: Hot wire instruments - Ammeters, voltmeter
4. Electrostatic effect: Electrostatic voltmeters.
5. Hall effect: Flux meter, Pointing vector wattmeter.

Any four effects with one instrument 1 mark each

2 b) Describe method of eddy current damping with neat sketch.

2 b) **Ans:**

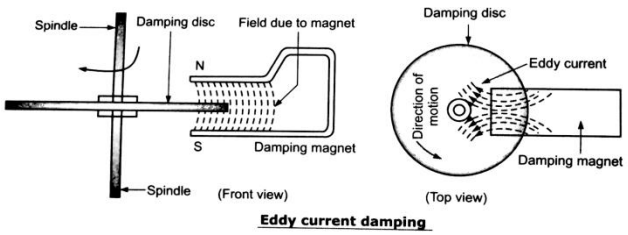
Eddy Current Damping:
In PMMC instruments a coil, wound on aluminium former, is placed in the magnetic field produced by two permanent poles as hown in the figure. When the coil is in motion due to deflectin torque, the aluminium former acts as one turn shorted coil and cuts the magnetic field, resulting an emf and current. The current is called eddy currnet. The current carrying aluminium former (conductor) is in magnetic field, hence force is exerted on former. The direction of force is such that it always opposes the motion. This force exists only when the coil is in motion, if motion stops, the force becomes zero. Thus this force is used to damp the oscillations.



Any one figure 2 marks + 2 marks for explanation

OR

The edge of the aluminium disc is passed through the gap between the poles of damping magnet. When the disc is in motion, it cuts the magnetic field and emf is induced which produces eddy currents. These eddy currents interact with the same magnetic field and force is produced on the disc which always opposes the motion. So whatever may be the direction of motion, this force opposes it. This force damps the oscillations in the disc



Eddy current damping

and tries to maintain smooth movement.

2 c) A moving coil instrument with FSD of 25 mA and internal resistance of 50 Ω is to be used as 0-10 A ammeter and 0-500 V voltmeter. Calculate necessary shunt/series resistances for it.

2 c) **Ans:**

Given: Full scale deflection current I_G = 25 mA .

Resistance of movin coil instrument R_G = 50 Ω.

Shunt resistance R_{sh} :

For full scale deflection when the arrangement carries current of I = 10 A, using the principle of equal voltage across parallel resistances of R_G and R_{sh},

$I_G.R_G = (I - I_G) R_{sh}$ 1 mark

$R_{sh} = I_G.R_G/(I - I_G) = 25 \times 10^{-3} \times 50/(10 - 25 \times 10^{-3})$

$= 0.1253$ ohm

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

R_{sh}= 0.1253Ω 1 mark

Series Resistance R_{se}:

With (V_M = 500 V) applied to the series combination of moving coil and the series resistance R_{se} ,to use it as voltmeter to read 500 V, the max current allowed is 25 mA.

$500 = 25 \times 10^{-3} \times (R_{se} + R_G)$ 1 mark

$R_{se} = 20000 - R_G = 20000 - 50 = 19950$ ohm

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

R_{se}= 19950 Ω 1 mark

2 d) Write a step by step procedure for callibration of voltmeter.

2 d) Ans:

Procedure of calibration of voltmeter:

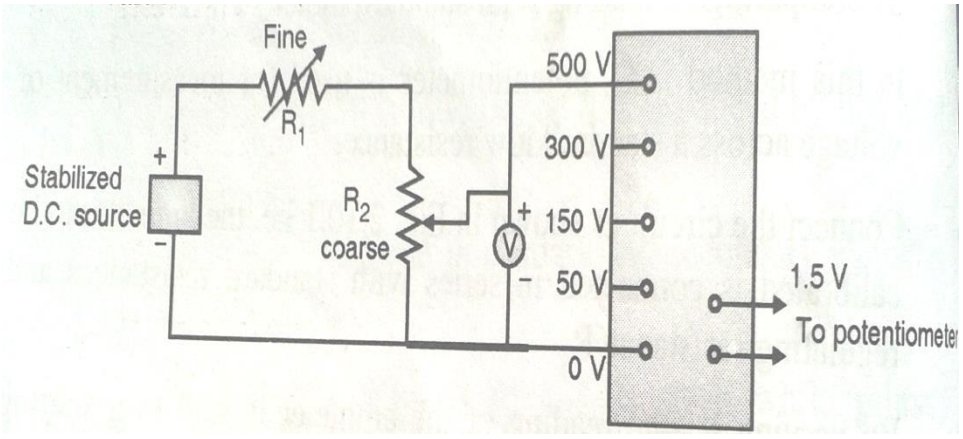


Diagram 2 marks

For calibration of voltmeter using DC potentiomter a voltage ratio box is required which consist 50Ω to 100kΩ variable resistors.

- The circuit is connected as shown in the figure. With the help of resistance R_1 and R_2 the reading of voltmeter is set to the certain value.
- Let the reading of votlmeter is 'V' and the voltage measured by DC potentiometer is Vp.
- The true value of the voltage is found out by multiplying the reading of potentiometer Vp by corresponding ratio of the voltage ratio box. Potentiometer is standardized before measurement.
- Calculate the errors in the voltmeter and take preventive measures to keep the errors within the limits.

Explanation 2 marks

OR

The sub-standard or calibrated meter and meter under test are connected in parallel across voltage source and readings are noted. Sub-standard meter reading is considered as true value and errors in the voltmeter are determined.

2 e) Give function and material for each of the following wattmeter component:
i) P.C. ii) C.C. iii) Pointer iv) Spring

2 e) Ans:

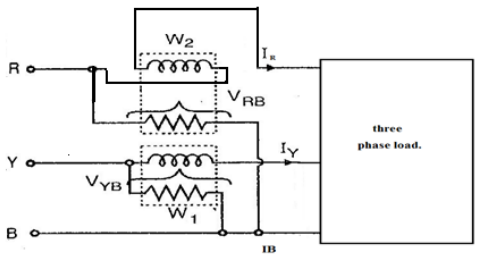
i) **P. C.:** It is made up of copper. It produces flux proportional to the voltage applied, for the production of deflecting torque.
ii) **C. C.:** It is made up of copper. It produces flux proportional to the load current, for the production of deflecting torque.
iii) **Pointer:** It is made up of aluminum. It gives reading on graduated scale.
iv) **Spring:** Spring is made from Phosphor bronze material. It produces necessary control torque.

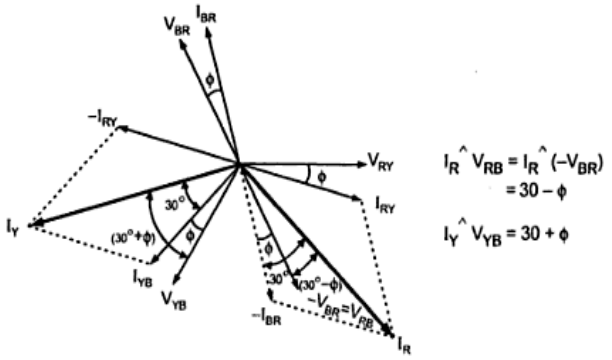
½ mark for material of each

½ mark for function of each

2 f) Derive the expression for power factor by two wattmeter method of power measurement.

2 f) Ans:





1 mark for diagram

$V_L = V_{RB} = V_{YB}$, $I_L = I_R = I_Y$
Ø = phase angle between voltage and current of the phases.

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

& $W_2 = V_{YB}\ I_Y\ \cos(30 + Ø)$
$= V_L\ I_L \cos(30 + Ø)$

$\therefore W_1 + W_2 = V_L\ I_L \{\cos(30 - Ø) + \cos(30 + Ø)\}$
$= V_L\ I_L \{(\cos30\cos Ø + \sin30\sin Ø) + (\cos30\cos Ø - \sin30\sin Ø)\}$

$= V_L I_L \{\cos30\cos Ø + \sin30\sin Ø + \cos30\cos Ø - \sin30\sin Ø\}$
$= V_L I_L \{2\cos30\cos Ø\}$
$= V_L I_L \{2 (\sqrt{3}/2)\cos Ø\}$
$\therefore W_1 + W_2 = \sqrt{3} V_L I_L \cos Ø$
$\therefore$ Total active power $P = (W_1 + W_2) = \sqrt{3} V_L I_L \cos Ø$

Now $W_1 - W_2 = V_L I_L \{\cos(30 - Ø) - \cos(30 + Ø)\}$ 1 mark
$= V_L I_L \{(\cos30\cos Ø + \sin30\sin Ø) – (\cos30\cos Ø - \sin30\sin Ø)\}$
$= V_L I_L \{\cos30\cos Ø + \sin30\sin Ø – \cos30\cos Ø + \sin30\sin Ø\}$
$= V_L I_L \{2\sin30\sin Ø\}$
$= V_L I_L \{2 (0.5)\sin Ø\}$
$= V_L I_L \sin Ø$

Since total 3-ph reactive power $= \sqrt{3} V_L I_L \sin Ø$
Total reactive power $Q = \sqrt{3}(W_1 - W_2) = \sqrt{3} V_L I_L \sin Ø$ 1 mark
$\therefore (Q/P) = \sqrt{3}(W_1 - W_2) / (W_1 + W_2) = \tan Ø$
$Ø = \tan^{-1} [\sqrt{3}(W_1 - W_2) / (W_1 + W_2)]$
Therfore, **p. f. $= \cos Ø = \cos \{ \tan^{-1} [\sqrt{3}(W_1 - W_2) / (W_1 + W_2)] \}$** 1 mark

3 Attempt any FOUR of the following: 16

3 a) List any six desirable characteristics of measuring instruments and define any one of them.

3 a) Ans:

i) Accuracy: It is the closeness with which an instrument reading approaches the true value of the quantity being measured.

ii) 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.

Any six ½ mark each (=3 marks)

iii) Reproducibility- It is the degree of closeness with which a given value may be repeatedly measured.

iv) Drift: Drift is gradual variation in output over period of time that is independent to change in output operating conditions etc.

Any one definition 1 mark

v) Calibration: Calibration means comparing the measuring intrument with standared instrument to find out the error in the instrument under test.

vi) Resolution or Discrimination: The smallest incremement in input (the quantity being measured) which can be detected with certainty by an intrument is called its resolution or discrimination. **OR**
It is smallest measurable input change of an instrument.

vii) Sensitivity: It is the ratio of the change in output signal to the change in input signal or quantity being measured. **OR**

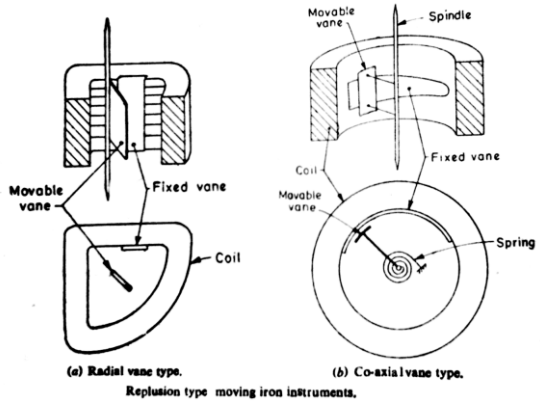
It is the ratio of the magnitude of the output or response to the magnitude of the input signal or quantity being measured.

viii) Reliability: It is the ability of an instrument to perform its duty keeping errors within the limits specified by the manufaturer.

ix) Repeatability: It is the closeness among the number of consecutive measurements.

3 b) Draw neat sketch of repultion type MI instrument and label it.

3 b) Ans:

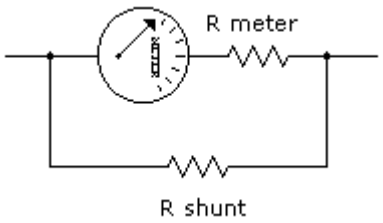


Repulsion type moving iron instruments.

Any one labeled diagram 4 marks (unlabeled 2 mark) (partially labeled 3 marks)

3 c) Derive the relation for shunt resistance for extention of ammeter range.

3 c) Ans:

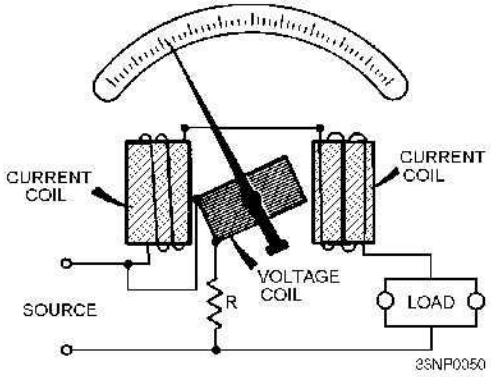


Let R_m = Resistance of ammeter
R_s = resitance of Shunt.
I = total current from mains
I_m = maximum rated current of ammeter
I_s = Current flowing through shunt, 1 mark

Then, $I = I_m + I_s$
Also $I_m R_m = I_s R_s$
OR 1 mark
$R_s = I_m R_m / I_s$
Subtitutig value of I_s from above equtations, we get
$R_s = I_m R_m / I – I_m = R_m / (I / I_m - I)$
$= R_m / (M – 1)$ 1 mark
where $M = I / I_m$, is the ratio of main current to the full-scale deflection current i.e maximum rated current of ammeter, is called as multiplying power of shunt.

3 d) Draw a neat sketch of dynamometer type wattmeter for 1-Φ power measurement.

3 d) Ans: Labeled diagram 4 marks

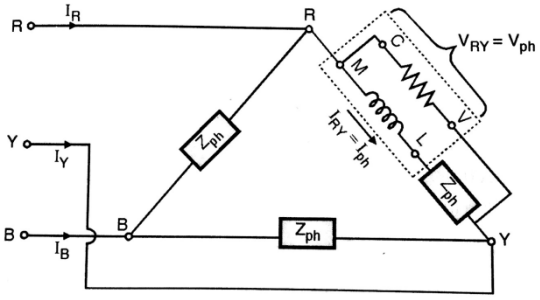


(unlabeled 2 marks)

(partially labeled 3 marks)

3 e) Draw a neat circuit to measure power of 3- Φ balanced delta connected load using one wattmeter. Explain its working.

3 e) Ans:



Measurement of 3-phase Power in Balanced Delta Connected Load by One-Wattmeter Method

1 mark

The current coil is connected in series with in one phase of load.($I_{RY} = I_{ph}$) 1 mark

The pressure coil is connected across any one phase of load ($V_{RY} = V_{ph}$)

$W = V_{pc} I_c \cos (V_{pc}^{\wedge} I_c)$ 1 mark

Therfore $W = V_{ph} I_{ph} \text{Cos}\Phi$

$W = P_{ph}$ 1 mark

Hence total power $P_T = 3 P_{ph} = V_{ph} I_{ph} \text{Cos}\Phi = 3 W$ watts.

3 f) List any four errors in inducton type energy meter. Give method of compensation for each.

3 f) Ans

1) **Error due to friction:** This error can be compensted 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 will come under the pole of a shunt magnet, the disc will stop running.
6) **Error in Registration:** This error can be compensted by adusting the braking

Any four errors with compensation 1 mark each

magnet or changing resitering system.

7) **Speed error:** This error can be compensted by readusting the compensating mechanisum.
8) **Overload error:** This error can be compensted by providing a 'flux diverter' to the current magnet.

4 Attempt any FOUR of the following: 16

4 a) Write any two advantages and two disadvantages of PMMC type instrument.

4 a) **Ans:**

Advantages of PMMC type instrument:

1. Scale is uniform
2. Power consumption is very low.
3. Can be used as ammeter or voltmeter of different ranges with the help of shunt and multiplier.
4. More sensitive as compared with MI type
5. The toque to weight ratio is high which gives a high accuracy.
6. Most accurate instrument for measurement of DC quantities.
7. Effective eddy current damping.
8. Errors due to stary magnetic fields are small, due to strong operating magnetic field.

Any two advantages and two disadvantages 2 marks each

Disadvantages of PMMC instrument:

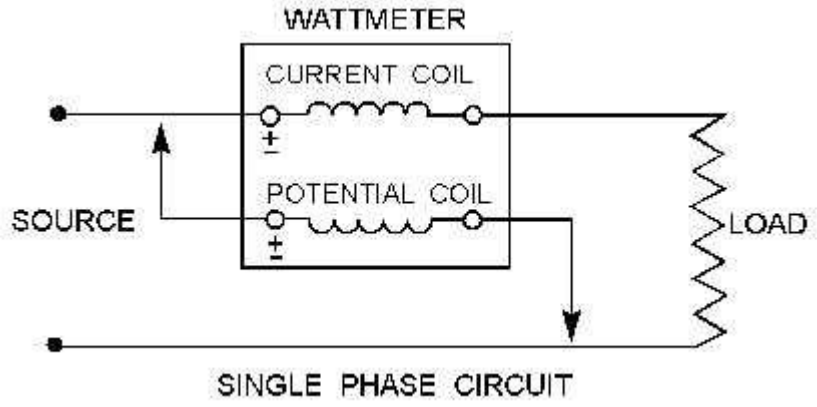
1) Costly
2) Used for measurement of DC only & not AC.
3) Thermoelectric e.m.f. may cause errors when it is used with shunts.
4) The strength of permanent magnet reduces with aging.

4 b) Draw a connection diagram of 1- Φ wattmeter. State rating of it for measurement of 2 kW load when connected to 230 V, 50 Hz.

4 b) **Ans:**

Wattmeter specifications: 10A, 250V or 300V 2 marks

Diagram:



2 marks

4 c) Write the position of two wattmeter readings in power measurement if value of p.f. is- (i) 1 (ii) 0 (iii) 0.5 (iv) between 0 to 0.5.

4 c) **Ans:**

In two wattmeter method the reading of two wattmeters are given by equations-

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

We will consider different cases of power factors

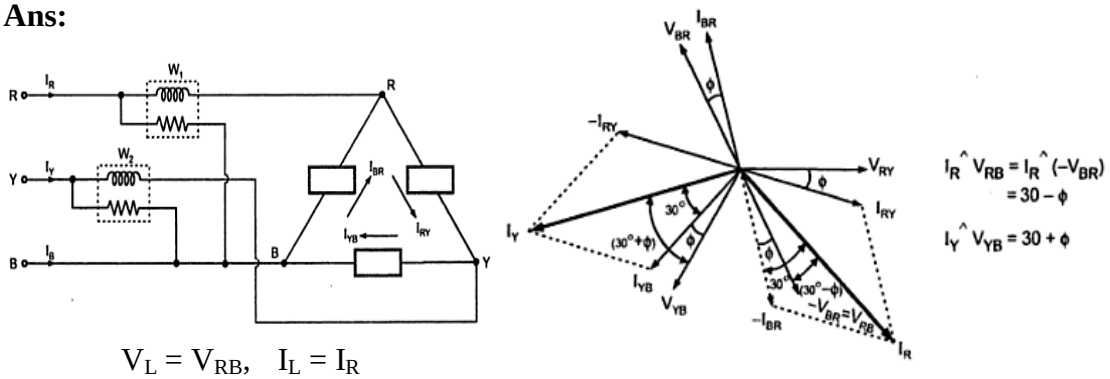
1. If power factor is unity i.e. p.f.=1 ($\Phi=0^0$)
   $W_1=V\ I\cos(30+0)$ and $W_2=V\ I\cos(30-0)$
   $W_1=V\ I\cos 30$ and also $W_2=V\ I\cos 30$
   Thus both the watt meters read positive equal readings.
2. If power factor is 0.5 lagging i.e. $\Phi=60^0$
   $W_1=V\ I\cos(30+60)$ and $W_2=V\ I\cos(30-60)$
   $W_1=V\ I\cos 90$ 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°. 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 need to be changed**.**
4. If power factor is 0 i.e. $\Phi=90^0$
   $W_1=V\ I\cos(30+90)$ 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.

Four cases with effect 1 mark each

4 d) Draw a neat circuit of reactive power measurement by two wattmeter method and explain it.

4 d) **Ans:**



1 mark for diagram

1 mark for phasor diagram

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

Ø = phase angle between voltage and current of the phases.

Reading $W_1 = V_L I_L \cos(30 - Ø)$ & $W_2 = V_L I_L \cos(30 + Ø)$

2 marks for explanation derivation

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

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

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

$= V_L I_L \{2 \sin30\sin Ø \}$

$= V_L I_L \{2 (0.5)\sin Ø \}$

$= V_L I_L \sin Ø$

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

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

4 e) With neat circuit diagram, explain calibration of energy meter by direct loading.

4 e) **Ans:**

There are three methods for testing/calibration:

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

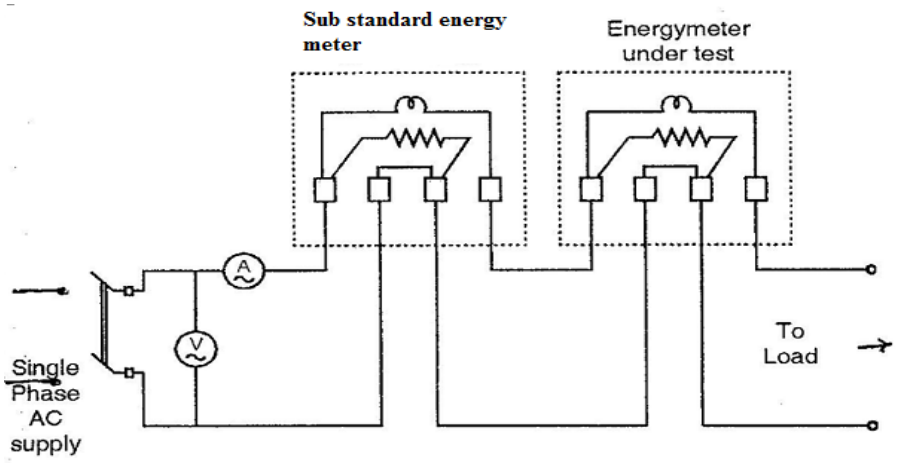
All above methods uses connection of energy meter under test in parallel with rotary substandard meter or precision grade meter. 2 marks for explanation

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 = $[(D – D_S)/D_S] \times 100$.



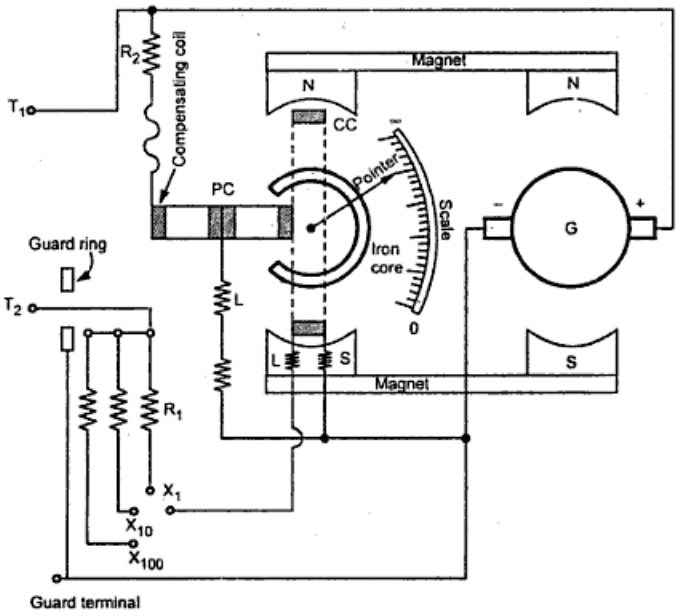
Calibration of energymeter

2 marks for circuit diagram

4 f) With neat sketch explain working of megger.

4 f) **Ans:**

Two coils the current coil and pressure coil are mounted at an angle on the same spindle and form the part of the moving system. These coils are connected to a small hand driven generator, with polarities such that torque produced by them will act in opposition to each other. The coils being placed in the air gap of a permanent magnet will move in it, the potential coil is connected in series with a fixed control resistance and also the current coil I sin series with a resistance to control the current flowing through it and the resistance under test .When the resistance under test is infinity no current flows through the current coil ,the pressure coil, the pressure coil will therefore set itself perpendicular to the magnetic axis , and the pointer indicates infinity on dial. If the resistance under test is very low, the high current will flow through the current coil, it makes the pressure coil; to lie in the direction of axis of permanent magnet, as the effect of pressure coil will be negligible the position of the pointer in this case is marked as zero. For value in between the pointer will indicate values in between zero and infinity, The dial is marked with values of resistances in mega ohms by calibration. When the instrument is not working the pointer may rest at any position on the dial.



Explanation 2 marks

Diagram 2 marks

5 Attempt any FOUR of the following: 16

5 a) Give two reasons of occurrence of following errors:
(i) Instrumental (ii) Environmental

5 a) **Ans:**

i) Instrumental Error: These errors are caused due to the mechanical structure of measuring instrument.

a) Inherent shortcomings of instruments: Instrument may read too low or too high.

b) Miss-use of instruments: Improper handling e.g. overloading, overheating, failure to adjust zero, use of high resistance leads.

c) Loading effect: causes distortion in original signal.

2 marks each

ii) Environmental Error: These are because of surrounding conditions such as temperature, pressure, humidity, dust, vibrations, or external magnetic fields or electrostatic fields.

5 b) Write any two advantages and two disadvantages of dynamometer type wattmeter.

5 b) **Ans:**

Advantages of dynamometer type wattmeter:

1) As the coils are air cored, these instruments are free from hysteresis and eddy current errors.
2) They have precision grade accuracy.
3) They are very useful as transfer instruments.
4) They can be used for A.C. and D.C. measurement.

Disadvantages of dynamometer type wattmeter:

1) They have non-uniform scale.
2) It has low torque-weight ratio and hence has low sensititvity.
3) Low torque-weight ratio gives increased frictional losses.
4) More costly.
5) Due to air cored coils, they have weak magnetic field and operating currents are large.
6) These instruments are sensitive to overloads and mechanical impacts.
7) Bulky construction.
8) Easily affected by stray magnetic fields.

Any two advantages and two disadvantages 2 marks each

5 c) Explain V- I method of measurement of medium resistance.

5 c) **Ans:**

Make the connections as per the circuit diagram. 1 mark

For a particular value of supply voltage, take reading of voltmeter and ammeter. Then measured resistance = R =V/I 1 mark

To minimise the error take 4 to 5 observation for the same resistance but with different supply voltages.

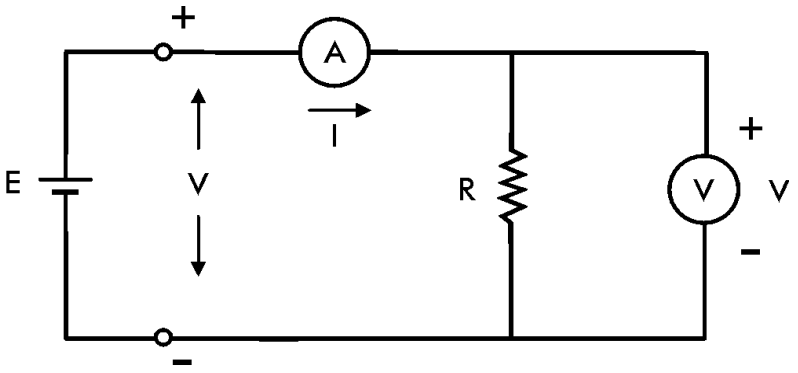
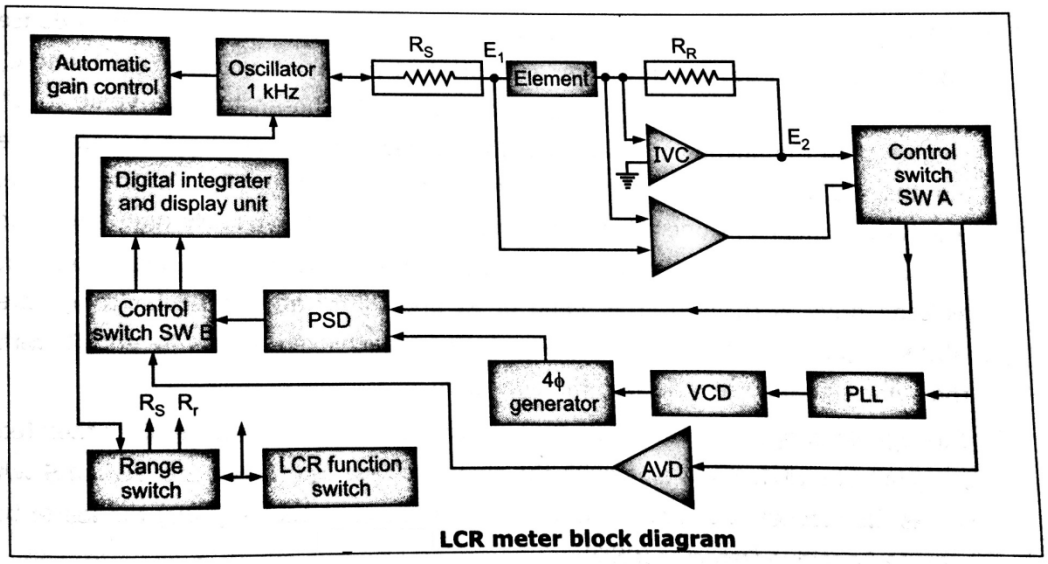


Figure or equivalent diagram 2 mark

5 d) Draw a labeled block diagram of LCR meter.

5 d) Ans:

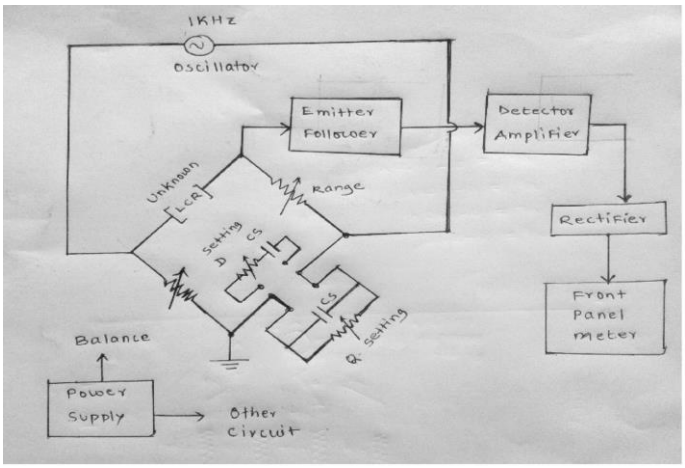


(Labeled diagram 4 marks)

(unlabeled 2 mark)

(partially labeled 3 marks)

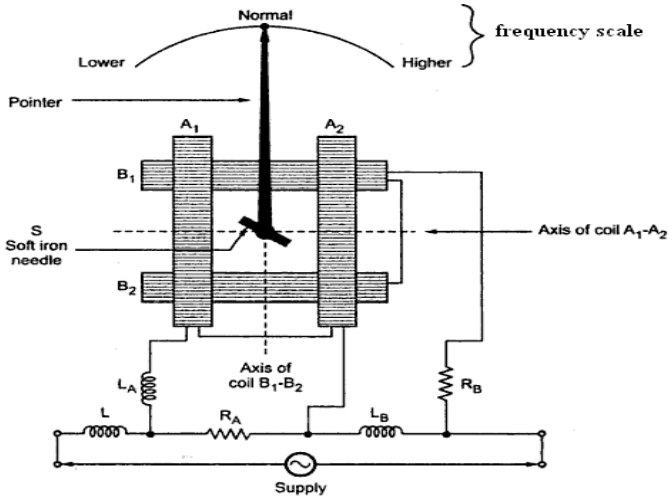
OR



5 e) Explain working of Weston type frequency meter with neat sketch.

5 e) **Ans:**

Weston frequency meter:



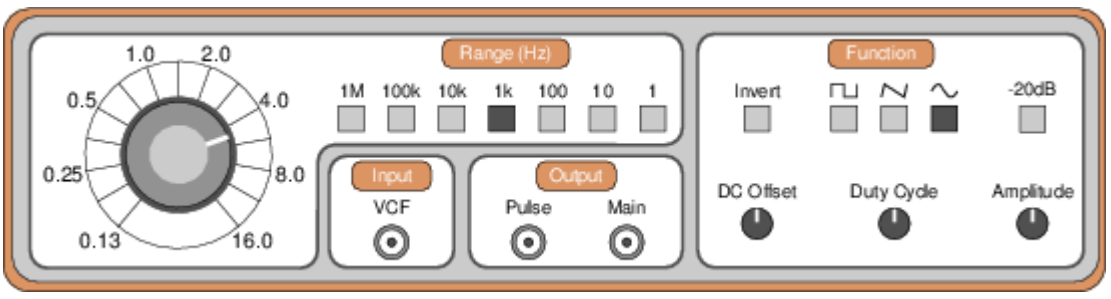
(Labeled diagram 2 marks) (unlabeled 1 mark)

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.

Operation 2 marks

5 f) Draw a labeled front panel diagram of function generator.

5 f) **Ans:**



(Valid diagram labeled 4 marks) (unlabeled 1 mark) (partially labeled 2 marks)

6 Attempt any FOUR of the following: 16

6 a) Secondary of CT is never open circuited – explain.

6 a) **Ans:**

The secondary of C T should be always kept closed. If it is necessary to disconnect

the instrument, the secondary terminals must be shorted by low resistance.

The ampere turns produced by primary will remain the constant and no reduction in its value will take, if secondary is kept open. — 1 mark

If no current flows in secondary, no ampere turns are produced by the secondary circuit. Hence only the ampere turns of primary are used by the magnetic circuit, which will produce large magnetic flux in the core and cause very large value of e.m.f. in the secondary and is dangerous to operator. — 2 marks

The ratio error and phase angle errors are likely to be much increased by such misconnection. — 1 mark

6 b) Compare PMMC and MI instruments on any four points.

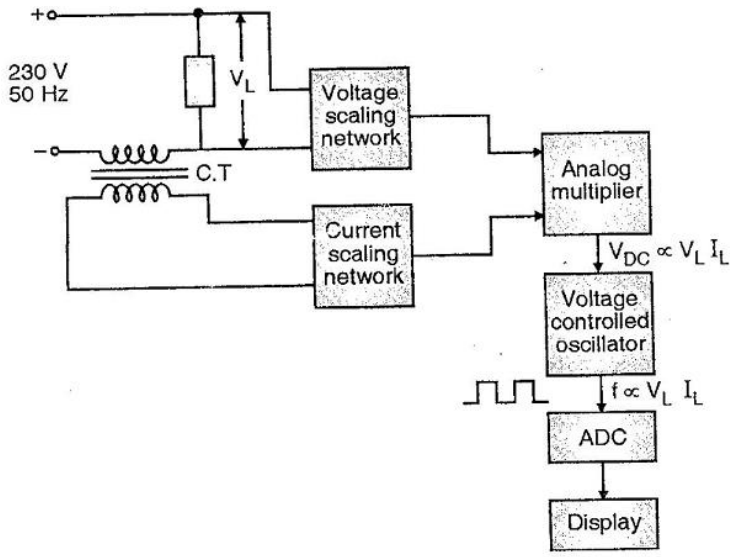
6 b) **Ans:**

Points	PMMC instruments	MI instruments
Principle	When current carrying conductor is placed in a magnetic field, it experiences a force	Piece of iron is attracted /repelled by magnet or magnetic field.
Scale	Uniform	Non-uniform
Weight	Lower weight for same torque	Comparatively higher weight.
Application	Used for only DC measurements	Used for DC as well as AC measurements
Cost	Higher cost for same range.	Cheaper for same range.

Any four valid points 1 mark each

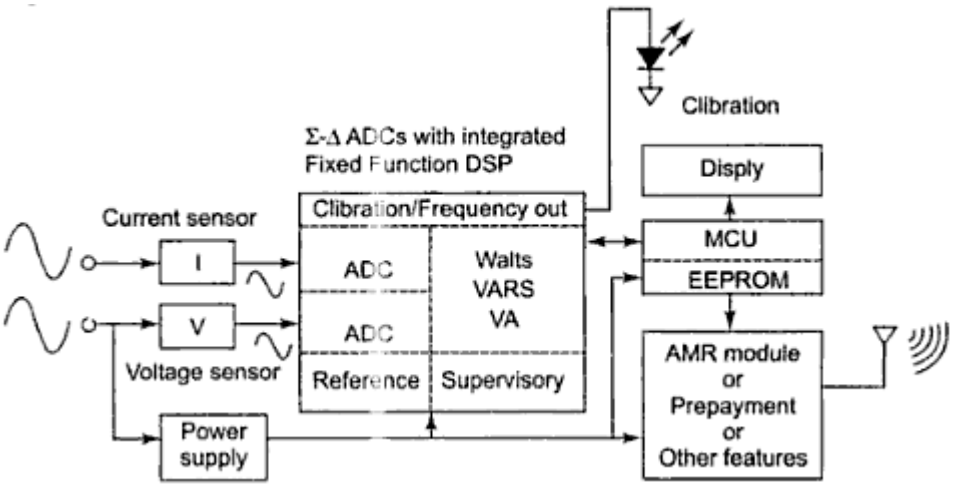
6 c) Draw a neat labeled block diagram of digital energy meter.

6 c) Ans:



(Labeled diagram 4 marks)
(Partially labeled 2 marks)

OR.



6 d) Explain capacitance measurement using LCR meter.

6 d) **Ans:**

Capacitance measurement using LCR meter:

An LCR meter, Inductance (L)-Capacitance (C)- Resistance (R) test equipment, is used to measure the inductance, capacitance and resistance of a component. It works on the principle of impedance measurement. 2 marks

In general versions of LCR meter, these quantities are not measured directly, but determined from a measurement of impedance. The necessary calculations are, incorporated in the instrument's circuitry; the meter reads L, C and R directly with no human calculation required. It will determine the relative change in magnitude of the repetitive variations of the voltage and current known as amplitudes.

For measurement of capacitance,
Select parameter selector switch on capacitor mode.
Select proper range with range selector switch. 2 marks
Connect the unknown capacitor to input terminals and note down readings on digital display.

6 e) Explain the construction of dynamometer type 3-Φ power factor meter.

6 e) **Ans:**

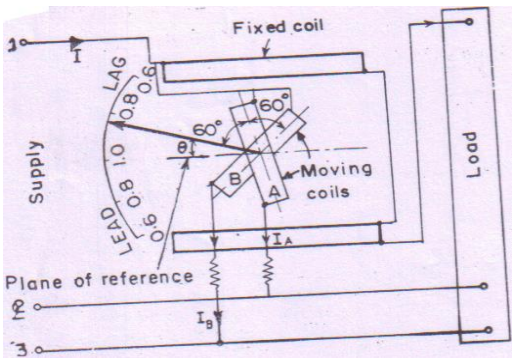


diagram
2 marks

Construction of dynamometer type 3-Φ power factor meter:

It consist of two fixed coils (current coils) and two moving coils (pressure coils) as shown in figure. The phase difference between two pressure coils is 120°. In series with pressure coil A, resistance R_A is connected and coil is connected between R and Y lines. While coil B has resistance R_B in series and is connected between R and B lines. No controlling torque is provided.

The torque exerted on coil A is in opposite direction w.r.t. the torque on coil B. When both torques becomes equal, the moving system becomes stationary and meter shows p. f. of the load on the scale. — construction 2 marks

6 f) State the function of following w.r.t. CRO :
- (i) Vertical deflection plate
- (ii) Horizontal deflection plate
- (iii) Blanking circuit
- (iv) Synchronizing circuit.

6 f) **Ans:**

Vertical deflection plate:

The signals, to be examined, are applied to vertical deflecting plates through an attenuator and number of amplifier stages. As the signal, not being so strong, vertical amplifiers are required to produce measurable deflection on the CRT screen.

Horizontal deflection plate:

The horizontal deflection plates are fed by a sweep voltage that produces a time base. They are fed directly when voltages are of sufficient magnitude. At the time of applying external signals to horizontal plates, they can be fed through horizontal amplifier via the sweep selection switch in the external position.

Blanking circuit:

When a saw tooth sweep voltage is applied to horizontal deflection plates, it moves the beam across the CRT in a straight horizontal line from left to right during the sweep or trace time. The slow movement of the spot will appear as a solid line when the rate of movement exceeds the threshold of persistence of vision. Below this threshold limit, the moving spot is perceived. If fly-back time is very small, the spot remains invisible. — 1 mark each

The retrace is blanked out by applying high negative voltage to the grid during the fly-back period. The blanking voltage is usually developed by the sweep generator.

Synchronizing circuit:

The signal being measured is to be synchronized with the sweep used. Synchronization has to be done to obtain a stationary pattern. This requires that the time base be operated at a submultiple frequency of the signal under measurement applied to vertical deflecting plates.

Three methods of Synchronization

a) Internal
b) External
c) Line.