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**

1 a) List the methods of providing damping torque in indicating type instruments.

1 a) **Ans:**

**Methods of providing damping torque in indicating type instruments :** Any two damping methods 1mark each

1) Air friction damping.
2) Fluid friction damping.
3) Eddy current damping.

1 b) State two purposes of calibration of measuring instruments.

1 b) **Ans:**

**Purposes of calibration of measuring instruments:**

- The purpose of calibration is to ensure that readings of an instrument are consistent with other instruments. It is also important in determining the accuracy of the instrument. Any two purposes 1mark each
- Calibration needed for evaluating and adjusting the precision and accuracy of measurement equipment. Instrument calibration is done to eliminate or reduce error in an instrument's readings.
- Send the instrument for calibration after the test helps user decide whether the data obtained were reliable and correct or not.
- If instrument is kept idle for a long time, the instrument's conditions will change, thus calibration in needed.
- Every instrument will need to be calibrated periodically to make sure it can function properly and safely.

1 c) Define following term,
i) Precision ii) Accuracy

1 c) **Ans:**

**1) 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.

**2) Accuracy:** It is the closeness of an instrument reading with the true value of the quantity under measurement. 1 mark each = 2 marks

OR

It is defined as the ability of a instrument to respond to a true value of a measured variable under reference conditions.

1 d) Find the M. F. of a wattmeter 1500W, FSD, when current and voltage ratings chosen are 15 Amp and 600 volt respectively.

1 d) **Ans:**

Multiplying Factor= (Current Range * Voltage Range)/ Full Scale Deflection 1 mark

M. F. = ( 15*600) / 1500 = 6 1 mark

1 e) Write two advantages of two wattmeter method for 3-phase power measurement.

1 e) **Ans:**

**Advantages of two wattmeter method for 3-phsae power measurement :** 1 mark each

1) Only two wattmeter are required which reduces cost of instruments
2) Can be used for balanced & unbalanced 3- phase loads
3) The circuit connections are independent of load connection.

any two = 2 marks.

1 f) Give the rating of a typical energy meter used for domestic purpose.

1 f) **Ans:**

Typical energy meter used for domestic purpose**:** 2 mark

Single Phase, 250V, 5- 10 A, 1200 rev/ kwh

1 g) State two merits of digital multimeter over analog multimeter.

1 g) **Ans:**

**Merits of digital multimeter over analog multimeter :**

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.

Any two merits 1 mark each

1 h) State the meaning of creeping error in energy meter and how it is prevented.

1 h) **Ans:**

**Creeping error:**

It is defined as the slow and continuous rotation of the disc of the energy-meter when only pressure coil is energized with no current in the current coil (load current = 0). 1 mark

In order to prevent the creeping on no load, two holes are drilled in the disc on diametrically opposite sides of the spindle. This causes sufficient distortion of the field to prevent rotation of the disc when one of the holes comes under the pole of shunt magnet. 1 mark

Also in other case, small piece of iron wire is attached to the edge of the disc. The force of attraction is exerted by the brake magnet on this iron wire is sufficient to prevent continues rotation of the disc on no load condition.

1 i) Classify resistances according to their values.

1 i) **Ans:**

**Classification of resistances :** Classification 1 mark.

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

Ranges 1 mark

1 j) State the use of synchroscope.

1 j) **Ans:**

**Use of synchroscope :** 2 marks

The synchroscope is used to determine the exact instant of switching required to connect the alternators in parallel or put an alternator across the infinite bus.
Its pointer gives the idea of the faster and slower machine to make adjustments of speed of alternators for synchronising.

1 k) Define instrument transformer. List two errors in instrument transformer.

1 k) Ans:

**Instrument transformer:**

Transformers which are used in conjunction with measurement instruments for measurement purpose are called "Instrument Transformers". Definition 1 mark

These transformers used for range extension of instruments like Ammeters, Voltmeters, Watt-meters, Energy-meters in AC circuit. These transformers are Current Transformer (CT) and Potential Transformer (PT).

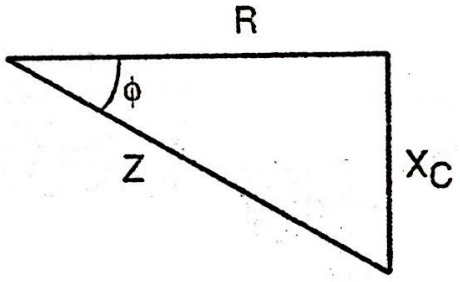
**Errors in instrument transformer:** Errors 1 mark

1) Ratio error
2) Phase angle error

1 l) Draw impedance triangle in series R-C circuit.

1 l) Ans:

**Impedance triangle in series R-C circuit:** 2 marks




**2 Attempt any four of the following: 16**

2 a) Explain common errors in analog measuring instruments and state the reason due to which these errors occur

2 a) Ans:

**Systematic Error:**

**i) Instrumental Error:** These errors are caused due to the mechanical structure of measuring instrument. 1 mark

a) Inherent shortcomings of instruments: Instrument may read too low or too high. 1 mark

b) Improper use of instruments: Improper handling e.g. overloading,

overheating, failure to adjust zero, use of high resistance leads.

c) Loading effect: cause distortion in original signal.

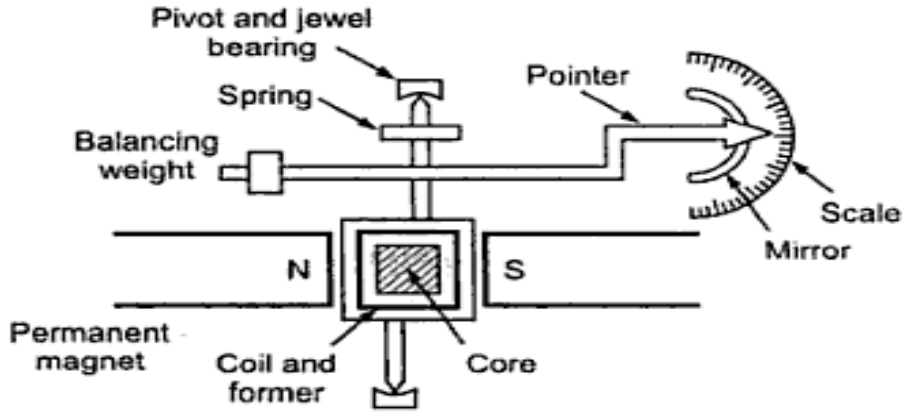
**ii) Environmental Error:** These are because of surrounding conditions such as temperature, pressure, humidity, dust, vibrations, or external magnetic fields or electrostatic fields. 1 mark

**iii) Observational Error:** Parallax errors, incorrect multiplying factor. 1 mark

2 b) Draw a neat sketch and label the parts of PMMC type ammeters.

2 b) **Ans:**

**PMMC type ammeter:**



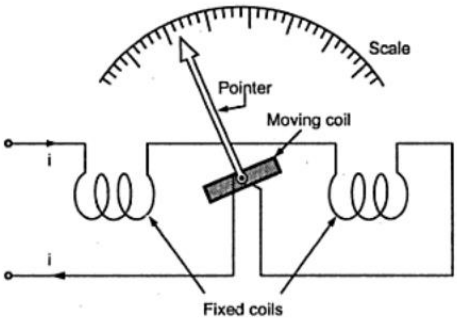

Labeled 4 marks,

Unlabeled 2 mark,

Partially labeled 3 marks.

2 c) Draw constructional features of dynamometer type wattmeter for single phase power measurement and label them.

2 c) **Ans:**




OR

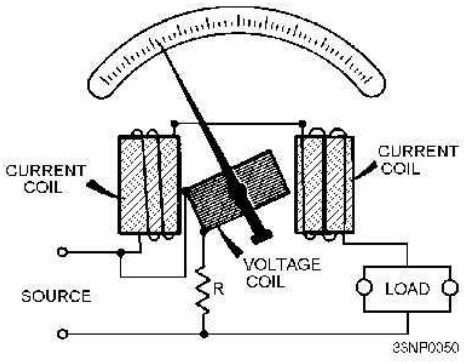



Diagram: labeled 4 marks,

unlabeled 2 mark,

partially labeled 3 marks.

2 d) A moving coil instrument gives a full scale deflection of 10 mA when the potential diffrence across its terminals is 100 mV. Calcaulate

i) Shunt resiatance for a full scale deflection corresponding to 100 Amp.

ii) Series resitance for full scale reading with 1000 Volt.

2 d) **Ans:**

$I_{FSD}$ = 10 mA Potential difference across meter = 100 mV

Therefore, Resistance of meter $R_m$ = 100 mV / 10 mA =10 Ω 1 mark

1) For 100A shunt resistance required is,

$R_s = R_m/M - 1$

where M is multiplying power of shunt = I/i

where I = Current to be measured

i = Current through the ammeter

OR $M = 100 / 10 \times 10^{-3} = 10000$ 1 mark

Resistance of shunt,

$R_s = R_m/M - 1$

$R_s = 10 /10000 - 1$ 1 mark

$R_s = 0.001\ \Omega$

2) For 1000 V

Resistance of multiplier, $R = V/I - R_m$

$R = 1000 /10 \times 10^{-3} - 10$

$R = 99990\ \Omega$ 1 mark

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

2 e) 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 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.

Any four errors with compensation 1 mark each

2 f) Draw neat circuit diagram and phasor diagram for measurement of reactive power in 3-phase balanced star connected load by one wattmeter method.

2 f) **Ans:**

**Circuit diagram for reactive power measurement:**

circuit

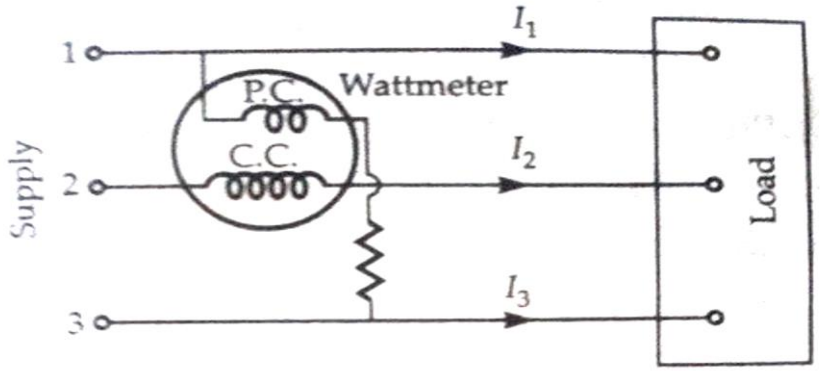
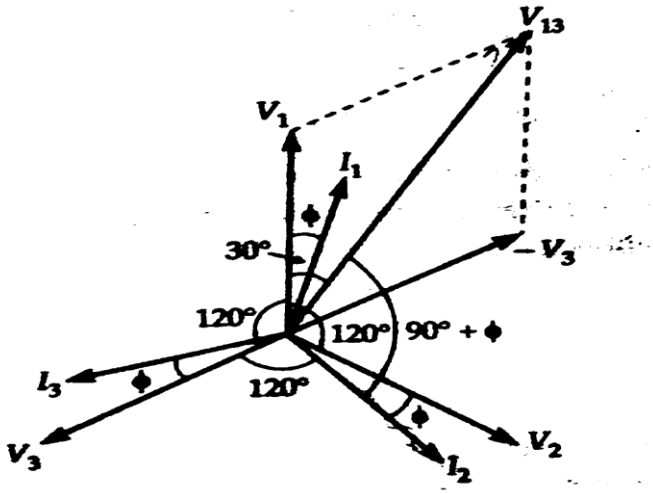



diagram 2 marks

**Phasor diagram:**



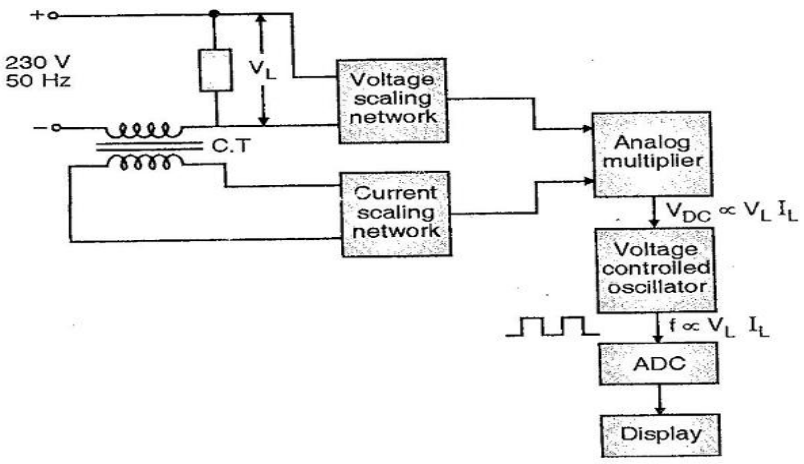

Phasor diagram 2 marks

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

3 a) Draw a block diagram of electronic energy meter. Write function of each block.

3 a) **Ans:**

**Electronic Energymeter:**




Labeled diagram 2 marks,

Unlabeled 1 mark.

**Functions of components/blocks:**

- CT reduces current to reasonable value for current scaling network.
- Voltage & current scaling networks reduce proportionally the voltage & current to values suitable for the analog multiplier.
- Analog multiplier gives a dc voltage proportional to the product of the voltage and current drawn from supply that is the power drawn.
- The voltage controlled oscillator gives a frequency proportional to its input (which is proportional to the power).
- The ADC converts the square wave frequency analog output to display the energy in watthour.

Any four ½ mark each = 2 marks

3 b) Mention the precautions to be taken while connecting CT and PT in the circuit.

3 b) **Ans:**

**Precautions to be taken while using instrument transformers:**

1. Secondary of CT is never kept open circuited when it is energised.
2. Secondary of PT is never kept short circuited when it is energised.
3. Power fuses must be connected in the primary circuit of PT.
4. Always ground the metallic cases of instrument transformers.
5. Secondaries should be grounded close to the transformer.
6. When secondaries of transformers are interconnected there should be only one grounded point.
7. Do not touch the leads of terminals of the instrument transformers unless they are properly grounded.
8. Never connect to DC circuits.

Any four points 1 mark each

3 c) Explain the essential toques in analog type measuring instruments.

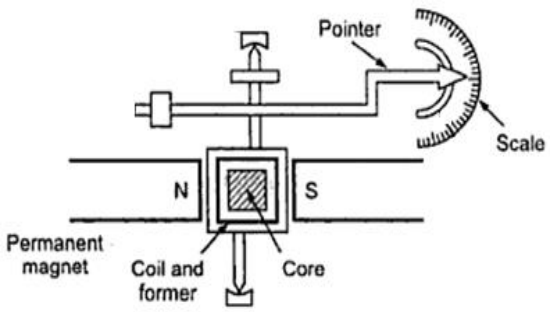
3 c) **Ans:**

**List of torques in analog instruments:**

1. Deflecting torque
2. Controlling / Restraining torque.
3. Damping torque.

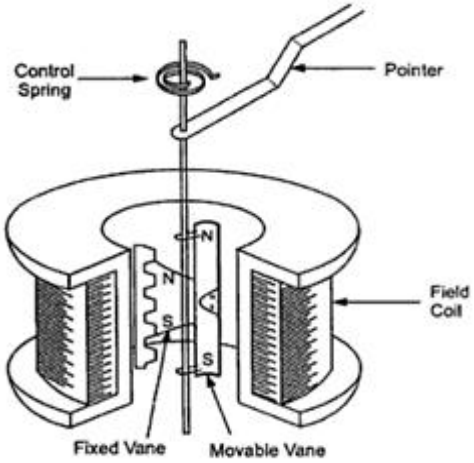
1 mark for list

1. **Deflecting torque:** To create deflection proportional to the quantity to be measured, this is normally current.
   - In PMMC instruments it is produced due to interaction of magnetic fields due to permanent magnet and current coil placed in it. Deflecting force is proportional to the permanent magnetic field and the current in the coil.

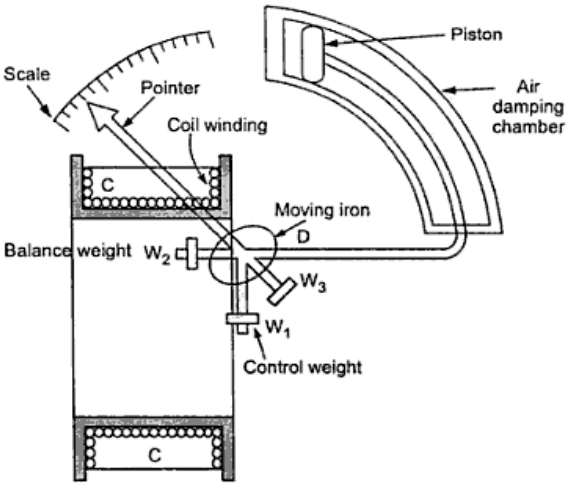



3 torques explanation 1 mark each

-Moving iron instruments: The current in field coil induces similar fields in the two iron vanes that repel each other to give the deflecting torque proportional to square of current in coil.




- Moving iron instruments with one coil producing magnetic field while the iron piece is attracted towards the coil where the force of attraction is proportional to the square of current in the coil

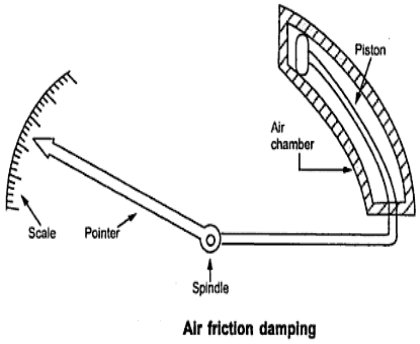



**2. Controlling / restraining torque:**

- 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.

This is provided by springs normally made of phosphor bronze that are used to hold the moving member along with spindle in the magnetic field producing the deflecting torque/force.

- This is also provided by control weights shown in figure above.



Air friction damping

**3. Damping torque:**

- To stop pointer/spindle at the final deflected position.
- Bring the pointer to stand still quickly.
- To minimize oscillations about final position.

For air damping: 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.

3 d) A 50 amp, 230 volt energy meter makes 61 revolutions in 37 second. If the meter constant is 520 rev/kwh. What is the pecentage error in the energy meter?

3 d) **Ans:**

The meter constant is 520 revolutions per kWh

520 rev =1kWh = 1000 watt hour

=1000*60*60 watt second

=3600000 watt second

Therefore 1 revolution = 3600000/520 = 6923 watt second 1 mark

Hence 61 revolutions = 61 x 6923 = 422303

= 422303 watt second has been recorded (registered). 1 mark

Now power consumed= 230 x 50

= 11500 watt

Energy to be actually recorded within 37 seconds will be (true value)

= 11500 x 37

= 425500 watt second. 1 mark

Therefore % error = {[true value - registered(reading) value]/true value} x 100

Therefore percentage error = [(425500 – 422307)/425500] x 100

= 0.75% 1 mark

3 e) Draw a labelled block diagram of LCR meter.

3 e) **Ans:**

**Block diagram of LCR meter:**

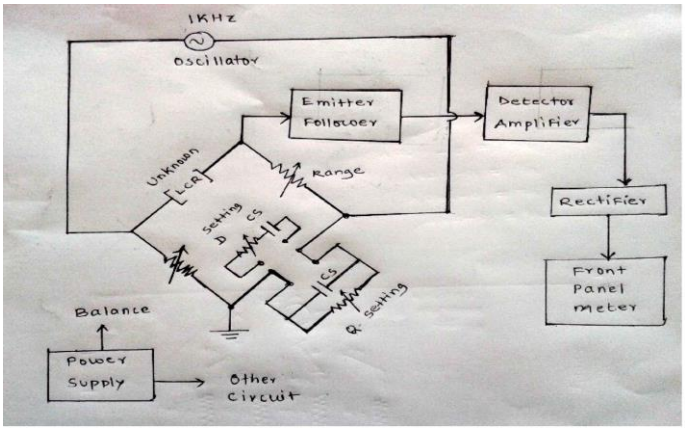
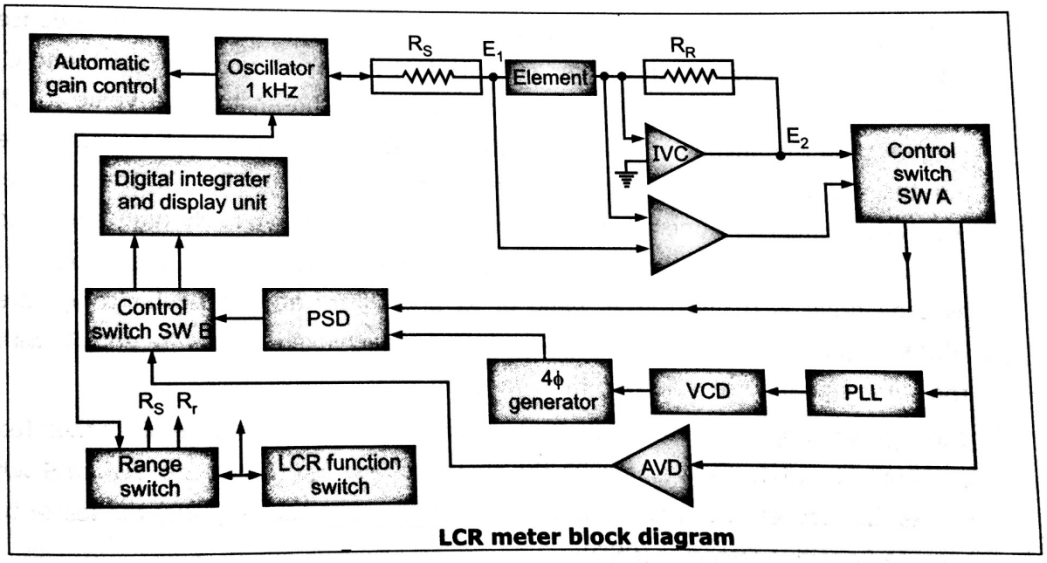



Diagram: labeled 4 marks,

unlabeled 2 mark,

partially labeled 3 marks.

OR



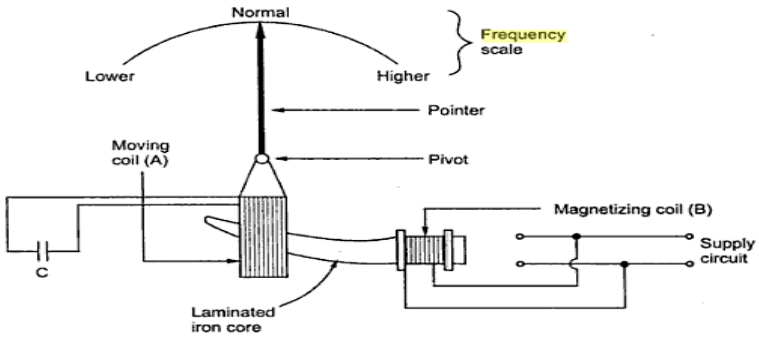

**LCR meter block diagram**

3 f) Draw the diagram and explain the working of ferrodynamic type frequency meter.

3 f) **Ans:**

**Ferrodynamic type frequency meter**: (Electrical resonance type frequency meter):

It consists of a fixed coil. The supply whose frequency is to be measured is connected




Ferrodynamic frequency meter

1mark

across it. This coil is also known as magnetizing coil. It is mounted on a laminated iron core. The core has a typical varying cross section. It varies along the length and is

maximum at the end of core. The moving coil of it is pivoted over this iron core. The pointer is fixed to the spindle and the terminals of moving coil are connected to a suitable capacitor C .No controlling torque is required. 1mark

**Working:-**

Current flowing through magnetizing coil produces flux in the iron core which will set up an emf in the moving coil .This emf lags the flux Ø by almost $90^0$. This will cause current I to flow through capacitor C. If current is inductive it will lag induced emf and a torque will act on the coil. If current is capacitive then also the torque will act, but if the inductive reactance is equal to capacitive reactance two torques will act on the moving coil. The capacitive reactance is constant for given frequency but the inductive reactance depends upon the position of pivoted coil on the core. The nearer the coil approaches the magnetizing coil, the greater is it's inductance .The moving coil is pulled towards the magnetizing coil until both the reactances are exactly equal. i.e. when torque is zero. The value of capacitor is so selected that the moving coil takes up a convenient position when frequency is of normal value. 2 marks

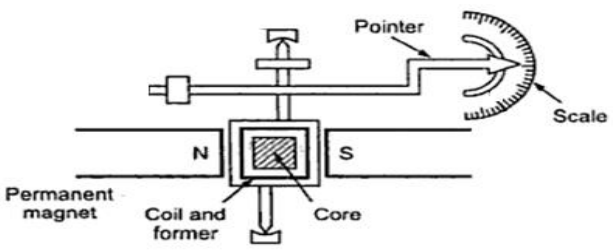
**4 Attempt any FOUR of the following: 16**

4 a) Explain the various effects of electricity utilized in measuring instruments. Write the name of instrument based on each effect.

4 a) **Ans:**

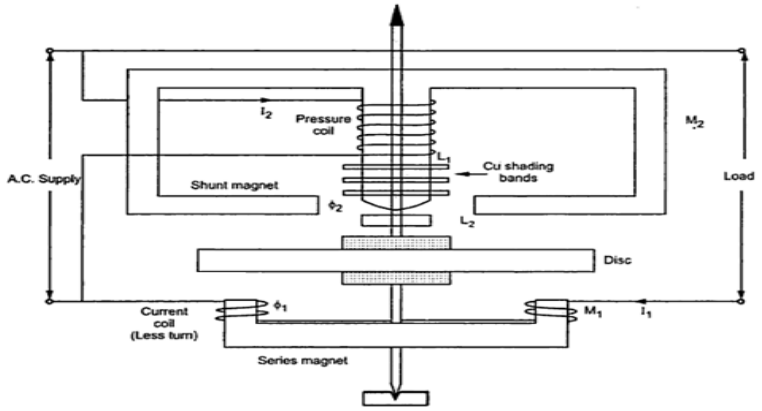
**Effects of Electric Current:**

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.
   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. Any two effects 2 mark




name of instrument ½ mark each= 2 mark

   Examples: Moving iron type instruments, Moving coil type instruments, Electrodynamometer type instruments, Induction type instrument.
2. Electromagnetic induction effect:
   When an aluminum disc is placed in the gap between two electromagnets, as shown in figure, supplied with AC supply, then an emf is induced in the disc. This emf circulate current in disc. The torque is exerted on the disc due to interaction between induced current and magnetic flux; which rotates the disc.




Examples: Induction type Ammeters, voltmeters, wattmeters, energy meters etc.

3. Heating effect:
   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.
   Examples: Hot wire instruments - Ammeters, voltmeter
4. Electrostatic effect:
   When two metal plates are charged, there is a force of attraction or repulsion on them. The force exerted is given by $F \alpha (Q_1Q_{2)} / d^2$ and is used for movement of pointer.
   Where $Q_1$ and $Q_2$ are charges on two plates
   D is distance between two plates
   Example: Electrostatic Voltmeters.
5. Hall effect:
   If a strip of conducting material carries current in the presence of transverse magnetic field, then an emf is produced between two edges of conductor which is known as Hall effect. The magnitude of the voltage depends on the current, flux density and property of conductor (i.e Hall effect coefficient). This emf is amplified and then measured
   Example: Flux meter, Pointing vector wattmeter.

4 b) Write comparison between M I instrument and M C instruments (any four point).

4 b) **Ans:**

| Points | MC 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 |
| Torque/Weight ratio | Higher | Lower |
| Application | PMMC instruments are used for only DC measurements | Used for DC as well as AC measurements |

Any four points 1 mark each

| | | |
|---|---|---|
| Cost | Higher cost for same range. | Lower cost for same range |
| Damping | Eddy current | Air friction |
| Sensitivity | More sensitive | Comparatively less sensitive |

4 c) Draw neat sketch of attraction type moving iron instrument and label it.

4 c) Ans:

**Attraction type MI instrument:**

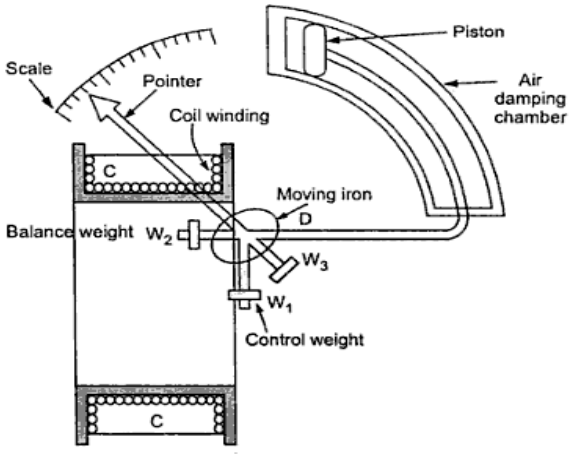



Diagram: labeled 4 marks,

unlabeled 2 mark,

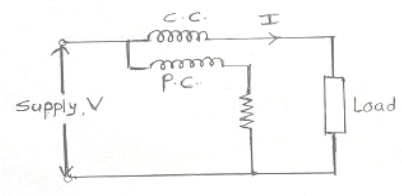
partially labeled 3 marks.

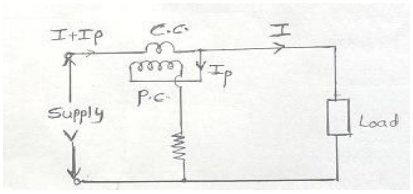
4 d) Explain any four errors occurring in wattmeter.

4 d) **Ans:**

**Errors in wattmeter:**

1. **Errors due to method of connection.**
   In uncompensated wattmeter , the reading of wattmeter includes the power loss in coils



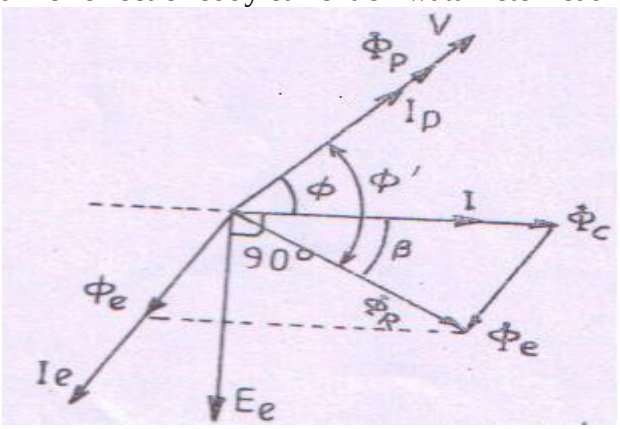

Any four errors expected with diagram 1 marks each

2. **Error due to pressure coil inductance.**
   Pressure coil inductance causes wattmeter to read more power than actual. A capacitor connected in parallel with pressure coil.
3. **Error due to Pressure Coil Capacitance.**
   The wattmeter reads less power. 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.**
   An emf induced in pressure coil due to current through the current coil. This emf of pressure coil opposes applied voltage. Hence errors are introduced.

5. **Error due to stray magnetic fields.**
   Main magnetic field gets disturbed by external magnetic fields, known as stray

magnetic fields, which causes errors.
To avoid this error, magnetic shield is placed over CC & PC.

6. **Error due to eddy currents**
Phasor diagram of effect of eddy current on watt meter reading:




$E_e$ = eddy emf, $I_e$ = eddy current, $I_P$ = current in pressure coil, $\Phi_e$ = flux due to eddy current, $\Phi_c$ = flux due to current coil, $\Phi_p$ = flux due to pressure coil,, $\Phi_R$ = resultant flux.
As seen from the diagram the resultant flux lags the current coil flux, due to which the phase angle between $\Phi_p$ and $\Phi_R$ increases. As the torque is a function of the magnitudes of $\Phi_p$ and $\Phi_R$ and angle between them, the resultant torque decreases. Thus error is introduced.

7. **Temperature error.**
Change in room temperature changes the value of resistance of pressure coil and the stiffness of the springs, causing errors.
Using zero temperature coefficient materials for coils and components, this can be minimised.

8. **Error due to vibration of moving system**.
This error is introduced when the external vibrations are somehow transferred to the moving system of the instrument. 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.

4 e) Three identical coils of (4.2+ j5.6) ohms are connected in star across 415 volt, 3-phase 50 Hz supply. Find
i) Phase voltage ii) Phase current
iii) The two wattmeter readings $W_1$ and $W_2$ when they are connected to measure total power

4 e) **Ans:**
Given: $V_L$ = 415V f = 50Hz $Z_{ph}$ = (4.2+j5.6) Ω = 7∠53.13° Ω
Impedance of coil, $Z_{ph} = 7\angle 53.13°\ \Omega$ 1 mark
In star connection, Line voltage ($V_L$) = $\sqrt{3}$ Phase Voltage = $\sqrt{3}V_{ph}$
Therefore, Phase voltage $V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{415}{\sqrt{3}} = 239.6\ V$ 1 mark
Phase Current $I_{ph} = \frac{V_{ph}}{Z_{ph}} = \frac{239.6}{7} = 34.23\ amp$
In star connection, Line current = Phase current = 34.23 amp 1 mark

Wattmeter readings:
$W_1 = V_L I_L \cos(30° - \emptyset) = (415)(34.23)\cos(30° - 53.13°) = 13063.56$ W
$W_2 = V_L I_L \cos(30° + \emptyset) = (415)(34.23)\cos(30° + 53.13°) = 1699.21$ W 1 mark

4 f) With neat sketch explain working of megger.

4 f) **Ans:**
**Megger:**

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 potential coil is connected in series with a fixed control resistance and the current coil is in 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 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 and it sets the pressure coil to lie in the direction of axis of permanent magnet. As the effect of pressure coil is negligible, the position of the pointer is towards zero. For resistance values in between zero and infinity, the pointer will indicate in between zero and infinity accordingly. 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

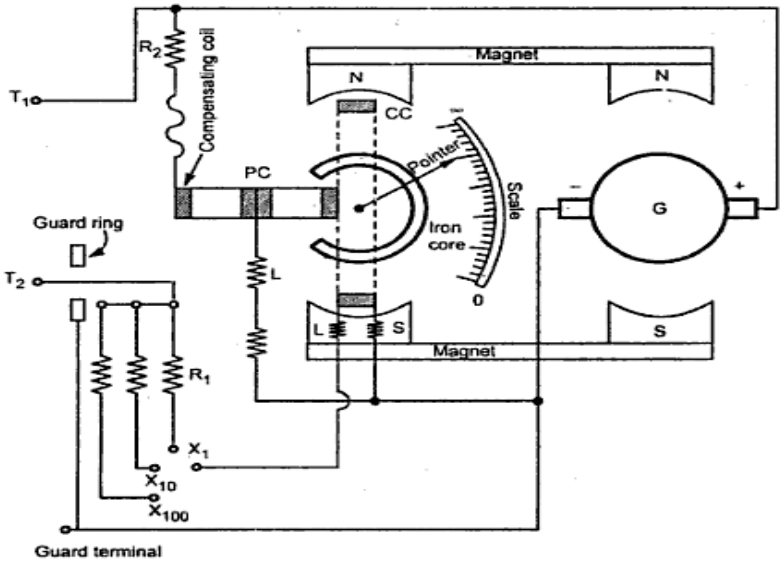
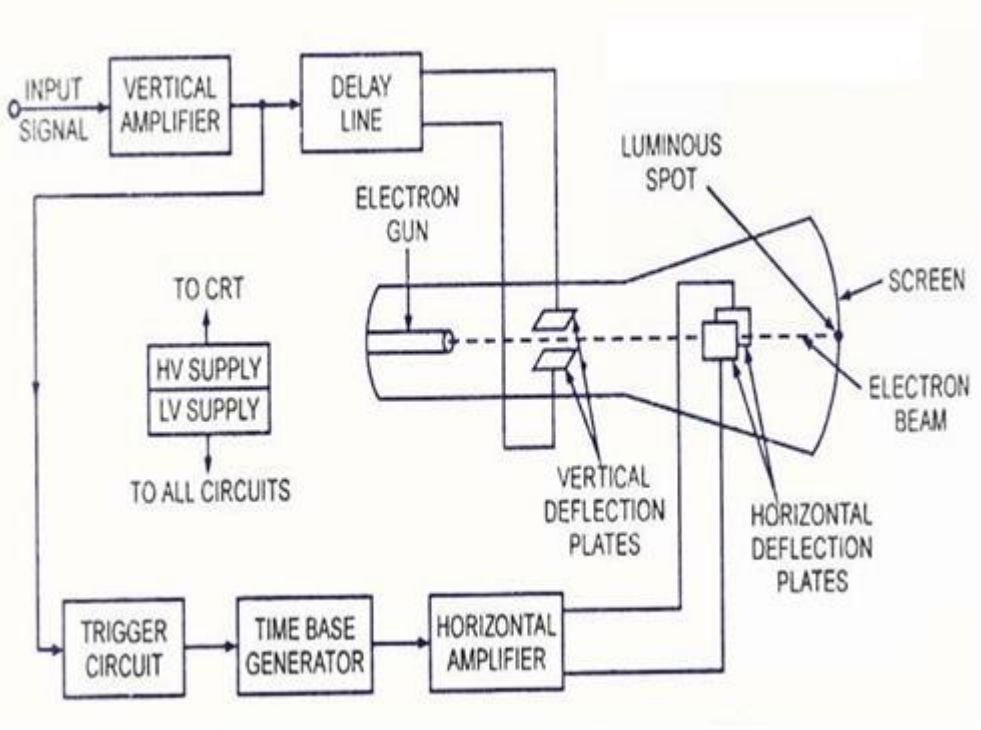



Diagram 2 marks

**5 Attempt any four of the following: 16**

5 a) Draw block diagram of Cathode Ray oscilloscope.

5 a) **Ans:**
**Cathode Ray Oscilloscope (CRO):** Any valid




Labeled diagram 4 marks

5 b) Derive the relation for multiplier resistance for extension of voltmeter range.

5 b) **Ans:**

This method is used for extension of range of AC and DC voltmeter. Multiplier is high resitance conneted in series with the meter coil.

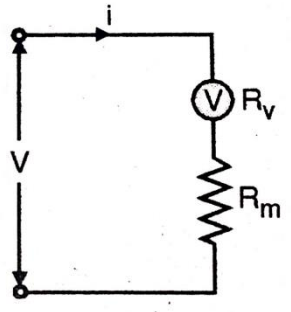



Diagram 1 mark

Let v – be the full scale deflection of the votmeter

$R_v$ – be the resitance of voltmeter

$R_m$ – be the resitance of multiplier

i - be the full scale deflection current flowing through meter = $(v/R_v)$

V – Votage to be measured

Therefore $V = i R_v + i R_m$

$V = i ( R_v + R_m )$

$V / i = R_v + R_m$

$R_m = (V / i) - R_v$

Derivation 3 marks

5 c) Write concept of power factor and its significance.

5 c) **Ans:**

**Concept of power factor(pf):**

Power factor is defined as the factor by which the apparent power(S) must be multiplied so as to obtain the true power (P).

**OR**

It is the ratio of true power to the apparent power.

Therefore Power factor = True power(P) / Apparent power(S) 1 mark

Power factor = (VI cosϕ) / (VI) = cosϕ

Thus power factor is the cosine of angle between the applied voltage (V) and current (I) flowing through RL and RC series circuit. 1 mark

Higher the power factor, larger is the percentage of useful power out of the total (apparent) power. Lower the power factor, smaller is the percentage of useful power out of the total power. 1 mark

Therefore, for all practical purposes power factor should be always near to unity.

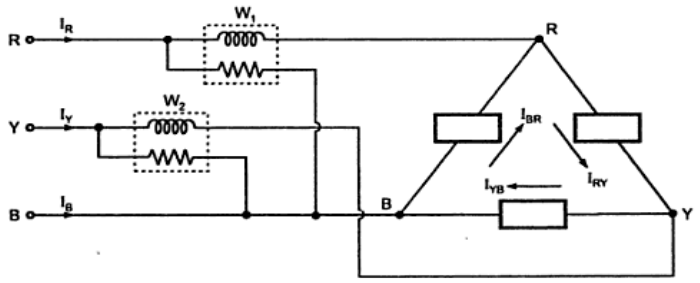
Also Power factor = cosϕ = R / Z

For pure resistive circuit pf is unity, for inductive circuits pf is lagging and for capacitive circuits pf is leading. Since the pf is the ratio of R and Z, it improves with increase in the resistive part of the impedance. 1 mark

5 d) Draw neat circuit diagram for measurement of power by two wattmeter method in 3-phase delta connected load and write the relation for total power.

5 d) **Ans:**

**Circuit diagram for measurement of power by two wattmeter method in 3- phase delta connected load:** 3 marks




Total power W = $(W_1 + W_2)$

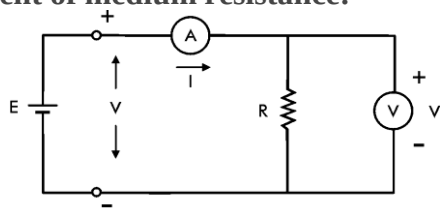
$= \sqrt{3}\ V_L\ I_L \cos(\phi)$ 1 marks

$= 3\ V_{ph}\ I_{ph} \cos(\phi)$

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

5 e) **Ans:**

**V-I method of measurement of medium resistance:** 2 marks for circuit diagram




2 marks for explanation

In this method, use suitable source, ammeter and voltmeter and connect them as shown in the above diagram.

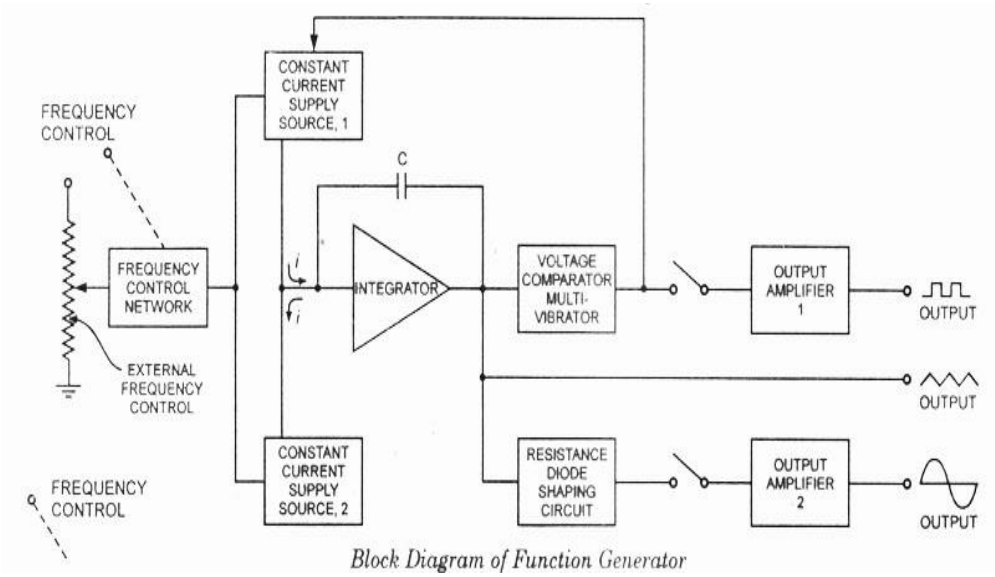
Take reading of voltmeter and ammeter, then value of resistance = R = V/I Ω

To minimise the error take 4 to 5 observation for the same resistance and take their average.

5 f) Draw block diagram of function generator.

5 f) **Ans:**

**Function Generator:**




*Block Diagram of Function Generator*

Any valid labeled diagram: 4 marks

**6 Attempt any four of the following: 16**

6 a) Explain absolute instruments and secondary instruments by giving one example of each.

6 a) **Ans:**

**Absolute instruments:**

- Gives magnitude of quantity in terms of physical constants of instrument
- Need no calibration
- Measurement is tedious and time consuming (as indirect) due to calculations needed to be done
- Very rarely used.

2 marks

e.g. Tangent galvanometer and Rayleigh's current balance.

**Secondary instruments:**

- Gives reading directly of the quantity being measured.
- Calibrated with respect to absolute instruments.
- Quick method as direct method of reading.
- Very widely used.

2 marks

e.g. Moving Coil instruments, M. I. instruments, Dynamometer type instruments, Induction type instruments etc.

6 b) Compare analog ammeter and voltmeter on the basis of

i) Connection in the circuit
ii) Resistance value
iii) Circuit symbol
iv) Power consumption.

6 b) **Ans:**

**Comparison between Analog Ammeter and Voltmeter:**

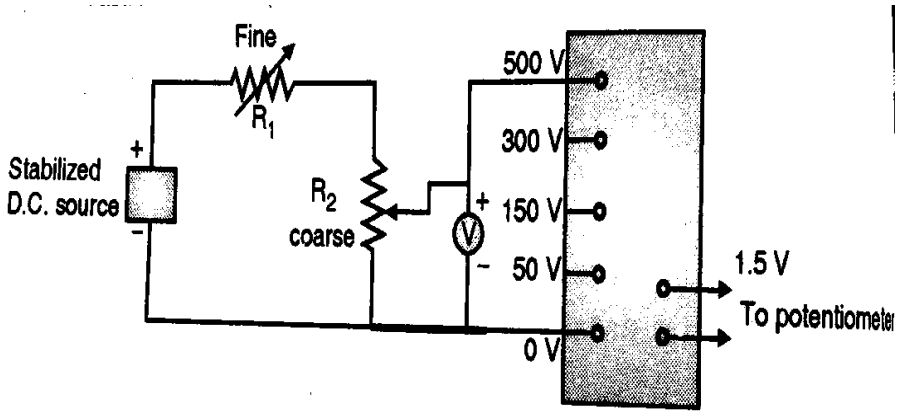
| Particulars | Ammeter | Voltmeter |
|---|---|---|
| Connection | Connected in series with the load | Connected in parallel with the load |
| Resistance value | Very low | Very high |
| Circuit symbol |   |   |
| Power consumption | $P_a = I^2 R_a$ watts<br>where, I = current flowing through ammeter<br>$R_a$ = Ammeter resistance | $P_a = (V^2/R_v)$ watts<br>Where V= Voltage across voltmeter<br>$R_v$ = Voltmeter resistance |

1 mark for each point

6 c) With the help of neat diagram explain calibration of voltmeter.

6 c) **Ans:**

**Procedure of calibration of voltmeter:**




Any valid Diagram 2 marks

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

- The circuit is connected as shown in above fig. 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.

Any valid Explanation 2 marks

6 d) Explain the term reactive power. Why it is sometimes essential to measure reactive power?

6 d) **Ans:**

**Reactive power:**

The reactive power (Q) is defined as the product of voltage(V), current (I) and sine of angle between voltage(V) and current( I) 2 marks

Therefore Reactive power Q = V I sinϕ

The reactive power is also called as imaginary power and its unit is VAR or kVAR.

Reactive power is part of total power which is not consumed by the load. Reactive power simply travels from source to load and back. It is therefore useless power and hence should be minimized.

**Need to measure reactive power:**

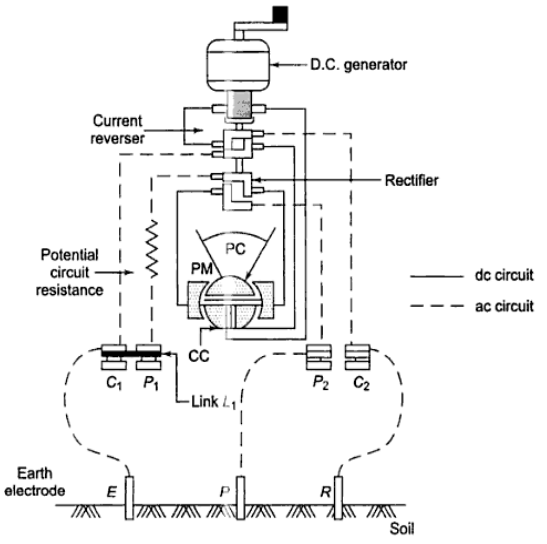
Increase in reactive power causes the reduction in power factor. There are several disadvantages of poor power factor. The supply utility system has decided to pay incentive or charge penalties if power factor of consumer increases or decreases beyond certain limit. Therefore it is essential to measure the reactive power so that corrective measures can be taken accordingly to maintain systems power factor near to the unity. 2 marks

6 e) Explain working principle of earth tester with neat diagram.

6 e) **Ans:**

**Earth tester:-**The resistance of the earth is measured with the help of earth tester. It consists of a hand cranked type generator, the magnet poles, crossed coils and flexible spirals. It consists of rotating current converter and a rectifier in addition to ohm meter. 2 marks

Both of these consists of simple commutator made up of L shaped segments, mounted on the generator and rotated at the same speed by the operating handle, each commutator has four fixed brushes in contact with it.




**Operation: -** It is connected to earth whose resistance is to be measured, and the other spike P and R, as shown in the figure. 2 marks

When handle is rotated the D.C. flows from the generator through the current coil of the movement to the current reverser, and alternating current from the reverser through the soil between the electrode E and R . This voltage drop between electrode P and E is rectified by the rectifier and fed to the potential coil of the meter. As the indication of the meter depends upon the ratio of the potential across its potential coil, and current passing through its current coil, the deflection of the pointer will indicate directly resistance in ohm of the earth under test.

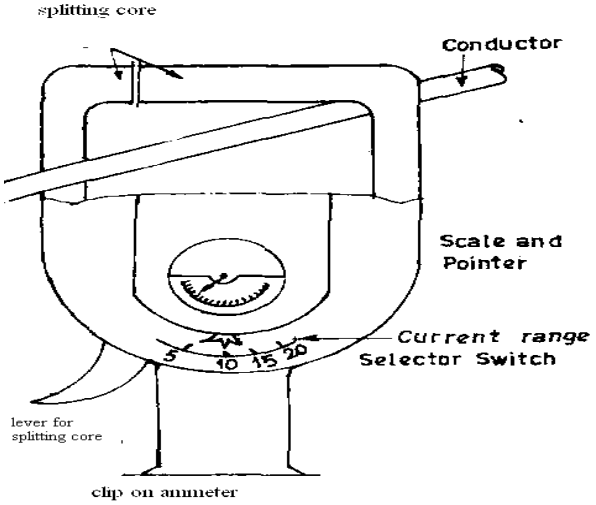
6 f) Explain the construction and working of Clip-on-Ammeter.

6 f) **Ans:**

**Clip-on-ammeter:**

Clip on ammeters are used to measure the high current flowing through bus bar, cable or fuse holders, which act as primary. It consists of split core current transformer whose secondary winding is connected to rectifier type moving coil instrument. The primary becomes conductor, whose current is to be measured. The split core gets aligned by the force of a spring tension. The core is covered with insulating material. Hence higher current through conductors can be measured by transformer action. A selector switch is provided to select secondary number of turns which ultimately changes the current range. For measuring current the core is opened by pressing trigger as shown and then clipped over the current carrying conductor. The dial will record the current directly.

Description 2 marks




2 marks for any one diagram

OR