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) Name any two electrical effect employed in measuring instruments.

1 a) Ans:
Electrical effect employed in measuring instruments:
1) Magnetic effect.
2) Electromagnetic induction effect.
3) Heating effect
4) Electrostatic effect
5) Chemical effect

Any two effects 1mark each

1 b) State the meaning of integrating instrument and give one application of it.

1 b) Ans:
Integrating instruments are those which measure the summation of quantities over a specified interval of time. 1 Mark

Energy meter is an example of integrating instrument. Energy meter is used for measurement of energy consumed, which is obtained by the integration(summation) of power supplied over a particular time duration
= $\int VIdt$. 1 mark

1 c) State any two general requirements of ammeter shunts.

1 c) Ans:
General requirements of ammeter shunts:
1) Low resistivity
2) Low temperature coefficient of resistance
3) Resistance should not vary over period of time

1 mark each any two = 2 marks

1 d) State the meaning meaning of 'Calibration'.

1 d) Ans:
Calibration: Calibration means comparing the measuring intrument with standared instrument to find out the error in the instrument under test. 2 mark

1 e) Give two disadvantages of PMMC instrument.

1 e) Ans:
Disadvantages of PMMC instrument:
1) Costly
2) Can be used on DC only & not on AC
3) Thermoelectric e.m.f. may cause errors when it is used with shunts
4) The strength of permanent magnet reduces with aging.

1 mark each any two = 2 marks.

1 f) Give significance of power factor.

1 f) Ans:
Significance of power factor: Cosine of angle between voltage & current in a circuit

is called power factor. It is a measure of the real power in a circuit. Inductive & capacitive circuits causes low PF. Low PF causes increase in current resulting in increase in copper losses in the system. — 2 mark

1 g) Name any two methods for power measurement in 3-Φ circuit.

1 g) Ans:
Methods for power measurement in 3-Φ circuit:
1) One 1- Φ wattmeter method
2) Two 1- Φ wattmeter method
3) Three 1- Φ wattmeter method
4) One 3- Φ wattmeter method

Any two methods 1 mark each

1 h) State the use of energy meter constant.

1 h) Ans: Energy meter constant is the no of pulses or revolutions per unit (kWh) of the energy meter. We may use it to measure the energy supplied or consumed. It may also be used to determine error in the meter. — 2 marks

1 i) Write two factors which affect earthing system.

1 i) Ans:
Factors which affect earthing system:
1) Specific resistance of the soil surrounding (Type of Soil) — 1 mark
2) Moisture content in soil
3) Depth of the soil at which the electrodes are buried.
4) Shape & material of earth electrode — 1 mark

1 j) List any four applications of LCR meter.

1 j) Ans:
Applications of LCR meter: — Any 2 points 1 mark each = 2 marks
1) Measurement of resistance
2) Measurement of self inductance
3) Measurement of mutual inductance
4) Measurement of capacitance.
5) Measurement of Q factor.

1 k) Name any two types of frequency meter.

1 k) Ans:
Types of frequency meter: — 1 mark each class = 2 marks
1) Ferromagnetic dynamic or resonance type
2) Moving iron type(Weston type)
3) Vibrating reed type(mechanical resonance type)

1 l) State function of intensity and focus control knob on front panel of CRO.

1 l) Ans:

Intensity control: The intensity of beam on the screen can be changed by intensity control potentiometer, which changes the grid potential w.r.t. cathode. The grid potential controls the amount of electrons leaving the cathode. 1 mark

Focus control: The focusing electrode acts like a lens whose focal length can be changed. The change is obtained by changing the potential of the focusing anode. 1 mark

2 Attempt any FOUR of the following: 16

2 a) Define following terms related to measuring instruments:
i)Accuracy ii) Reproducibility iii) Precision iv) Drift

2 a) Ans:

i)Accuracy: It is the closeness of an instrument reading approaches the true value of the quantity under measurement. 1 mark

OR

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

ii) Reproducibility- It is the degree of closeness with which a given value may be repeatedly measured. 1 mark

iii) 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. 1 mark

iv) Drift: Drift is gradual variation in output over period of time that is independent to change in output operating conditions etc. 1 mark

2 b) Give classification of systematic errors in instrument. Write two reasons due to which observational systematic errors are occurred.

2 b) Ans: **Systematic Error:**

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) 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. 1 mark

ii) Environmental Error: causes are 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. 2 marks

2 c) Draw neat sketch of attraction type MI instrument and label it.

2 c) Ans:

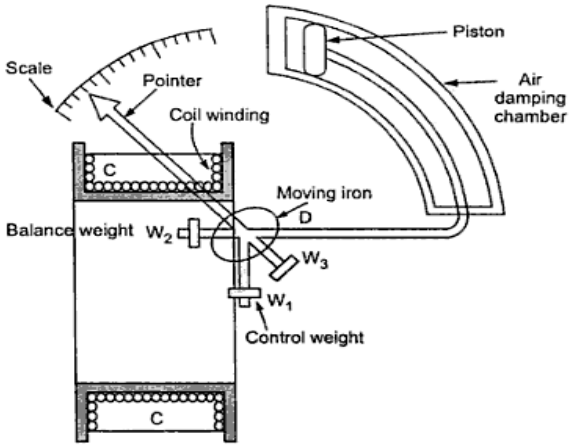


Diagram: labeled 4 marks, unlabeled 1 mark, partially labeled 2 marks.

2 d) A moving coil instrument gives FSD of 15 mA and has a resistance of 200 Ω . Calculate the value of series resitance so that it can be used as a 0- 75- 150 V voltmeter.

2 d) Ans:

I_{FSD}= 15 mA

R_m= 200 Ω

1) For 75 V

$R_m = V/I - R_v$ 1 mark

$200 = 75 /(15 \times 10^{-3}) - R_v$

R_v = 4800 Ω 1 mark

2) For 150 V

$R_m = V/I - R_v$ 1 mark

$200 = 150 /15 \times 10^{-3} - R_v$

R_v = 9800 Ω 1 mark

2 e) Write equations of all types of power. State their units, write relation between them

2 e) Ans:

Active Power – 3 phase = $P = \sqrt{3}\, V_L\, I_L \cos\Phi$ (Watt or Kilo watt) ½

Reactive Power 3 phase - $Q = \sqrt{3} V_L\, I_L \sin\Phi$ (VAR or kVAR) ½

Apparent Power 3 phase - $S = \sqrt{3} V_L\, I_L$ (VA or kVA) ½

Active Power – 1 phase - $P = V\, I \cos\Phi$ (Watt or Kilo watt) ½

Reactive Power 1 phase $Q = V\, I \sin\Phi$ (VAR or kVAR) ½

Apparent Power 1 phase - $S = V\, I$ (VA or kVA) ½

Relation between power

$S = \sqrt{(Q^2 + P^2)}$ 1 mark

2 f) Write any two advantages and limitations of one wattmeter method for 3-Φ power measurement.

2 f) Ans:

Advantages:

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

Advantages 2 mark

Limitations:

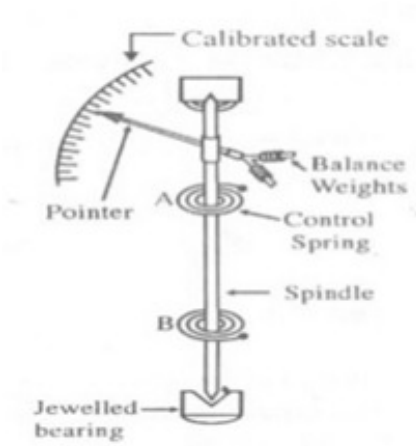
1) Used only for 3- Φ balanced load not for unbalanced loads.
2) Star point must be accessible for connecting the Pressure coil.
3) Delta connection must be opened to connect current coil.

limitations 2 marks

3 Attempt any FOUR of the following: 16

3 a) Describe spring control method of producing control torque in mesuring instrument. Write one advantage and one limitation of it.

3 a) Ans:



1. Two phosphor bronze hair springs of spiral shapes are attached to the spindle of the moving system of the instrument.

Fig 1 mark

2. They are wound in opposite direction

Description 1 mark

3. Pointer is attached to the spindle of the moving system

Advantages:

1) The spring control meters can be used in any position.
2) In some instruments springs can be used as current leads.
3) As springs are light in weight, practically there is no increase in weight of the moving system hence high torque to weight ratio.
4) Controlling torque can be adjusted easily.

Advantage 1 mark

Limitation:

1) Temperature change affects spring length causing change in magnitude of controlling torque.
2) Accidental stress in the springs may damage them & spring get a permanent set if stressed beyond their elastic limit.

Limitation 1 mark

3 b) Write any four differences between CT and PT.

3 b)

Ans:

CT	PT
CT corresponds to current transformer	PT corresponds to potential transformer
CT primary is connected in series with circuit of secondary winding is terminated with a low range ammeter.	PT primary is connected is parallel with circuit of secondary winding is terminated with a low range voltmeter.
Secondary winding is never open circuited when primary carries current	No such restriction are there with PT
Used for Range extension of ammeter	Used for Range extension of voltmeter.
Specified by their burden and nominal current ratio.	Specified by their burden and nominal voltage ratio.
Measured value of current = (reading of low range ammeter) x CT ratio	Measured value of voltage = (reading of low range voltmeter) x PT ratio

1 mark each any four = 4 marks

3 c) Name any four parts of PMMC instrument and state fuction of each.

3 c) Ans:

Permanent Magnet: Produces flux for deflecting torque production.

Moving coil: Current to be measured is passed through it producing deflecting torque.

Aluminium former: Coil is wound on it.Produces damping torque when it rotates in permanent Magnet.

Any four 1 mark each = 4 marks

Spring: Acts as leads for current leads and gives control torque.

Pointer: used to indicate the value over the scale.

Spindle: to mount the pointer, coil, control spring.

3 d) Draw only connection diiagram for measurement of voltage and current using CT and PT.

3 d) Ans:

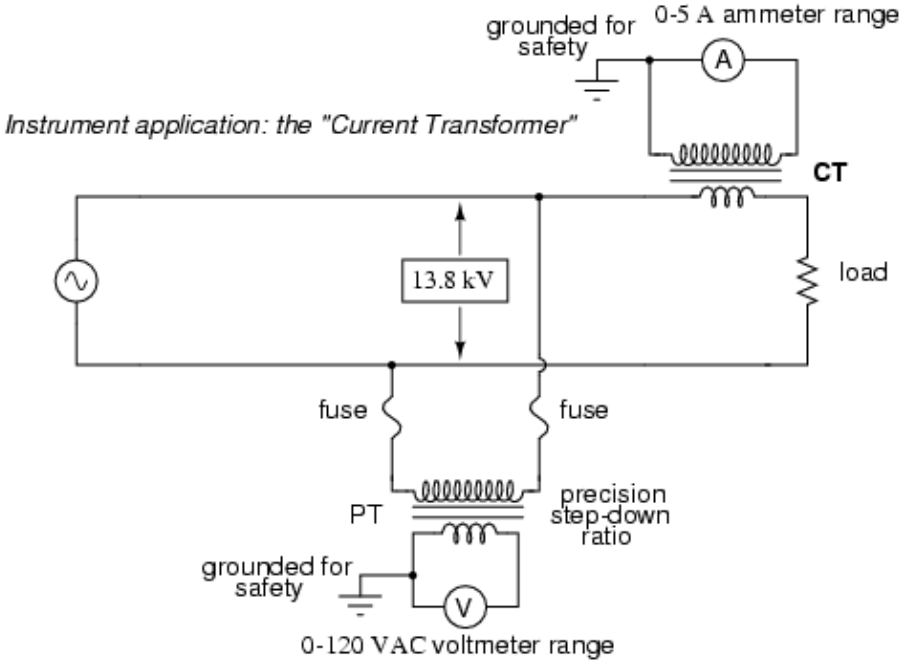
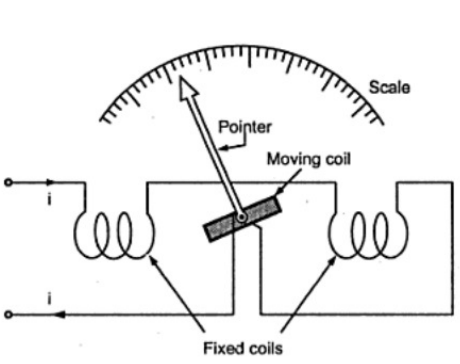


Diagram: labeled 4 marks, unlabeled 1 mark, partially labeled 2 marks.

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

3 e) Ans:



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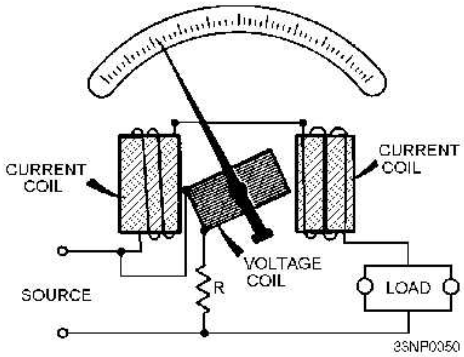


Diagram: labeled 4 marks, unlabeled 1 mark, partially labeled 2 marks.

3 f) Write any four advantages of digital energymeter over analog type.

3 f) Ans:

Advantages:

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

1 mark each any four = 4 marks

4 Attempt any FOUR of the following: 16

4 a) Name two types of secondary instruments each according to
i)Principle of operation, ii) Application.

4 a) Ans:
Secondary instruments each according to
i) Principle of operation: Hot wire Ammeter, Electrostatic voltmeter, induction wattmeter — 2 mark
ii) Application: Ammeter, voltmeter, wattmeter, Ampere-hour meter. — 2 mark

4 b) Write any two advantages and two disadvantages of ammeter shunt.

4 b) Ans:
Advantages:
1) More accuracy is obtained on D C measurements.
2) Easily connected in circuit. — 2 marks
3) Lower magnitudes may be measured more accurately.

Disadvantages:
1) Less accuracy is obtained on A C measurements due change in resistance & reactance — 2 marks
2) Power consumption is αI^2. Shunts can not be used for measurement of high currents.
3) The measuring circuit is not separated from the power circuit.

4 c) Compare PC and CC of wattmeter w.r.t.
i) Connection ii) Status iii) Number of turns iv) Gauge of wire.

4 c) Ans:

	Current coil	**Pressure coil**
Connection	Connected in series with load	Connected in parallel with load
Status	It is fixed coil in wattmeter	It is moving coil in wattmeter.
Number of turns	It is having less number of turns	It is having more number of turns
Gauge of wire	CC is having less SWG	PC is having more SWG

1 marks for each

4 d) State the method of compensation in watt-meters for errors due to
i)Eddy current ii) Stray magnetic field
iii) Vibration of moving system iv) change in temperature.

4 d) Ans:
i)Error due to eddy current- magnetic field produced by eddy currents disturbs the

main magnetic field.
This error is eliminated by avoiding use of solid metal parts. It can be avoided by using standard conductor for current coil. 1 mark

ii) Error due to stray magnetic fields- main magnetic field gets disturbed by external magnetic fields known as stray magnetic fields.
To avoid this error magnetic screen (magnetic seal) made up of magnetic material is placed over current coil and pressure coil. 1 mark

iii) Error due to vibration of moving system: Such errors can be avoided by designing moving system such that its natural frequency is greater than twice the frequency of deflecting torque of the wattmeter. 1 mark

iv) Temperature error-change in room temperature changes the value of resistance of pressure coil and the stiffness of the springs.
Using copper and resistance alloy having a negligible resistance temp coefficient in the ratio of 1:10 for pressure coil. 1 mark

4 e) A 415V, 3-Φ, Star connected induction motor draws a current of 20A. The input power is 15 kW. A wattmeter with CC in line Y and PC between R and B is used. Determine wattmeter reading.

4 e) Ans:

Total power = $\sqrt{3} * V_L * I_L * \cos \phi$ 1 mark

$15000 = \sqrt{3} * 415 * 20 * \cos \phi$

$\cos \phi = 1.0$ 1 mark

Wattmeter reading $W = V_L * I_L * \sin \phi$ 1 mark

$= 415 * 20 * 0$

$= 0$ VAr. 1 mark

4 f) State the effect of power factor on the reading of two wattmeters for 3-Φ power measurement.

4 f) Ans:

In two wattmeter method the readings 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 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 $W_2 = V I \cos(-30)$

four cases with effect 1 marks each = 4 marks

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. $\phi = 90^0$

$W_1 = V\ I \cos(30+90)$ 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.

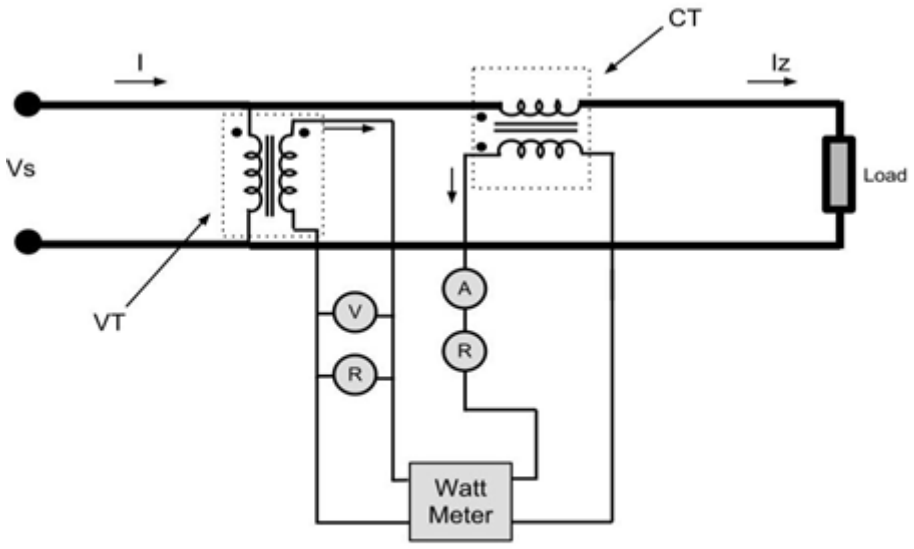
For leading power factors: - The readings of two watt meters only interchange.

5 Attempt any FOUR of the following: 16

5 a) State the necessity of extension of range in wattmeters. Explain any one method with neat sketch.

5 a) Ans:

Necessity of extension of range in wattmeters: To measure power in high voltage & high current network there is need to step down these voltages & current to low measurement & safe value which can be done by CT & PT. 2 mark



Range extension of Wattmeter

Connection of CT and VT

Explanation with any one figure 2 marks.

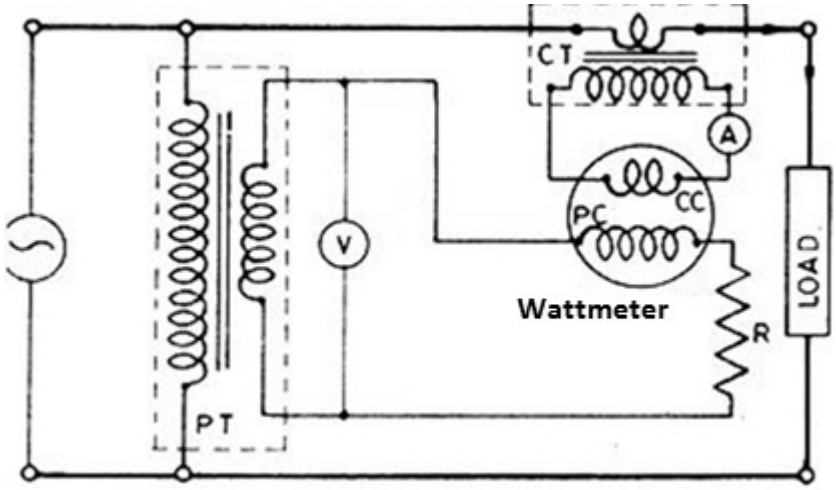


Figure shows range extension of wattmeter by using CT & PT.

5 b) List any four measure parts of 1-Φ induction type energy meter and state function of each.

5 b) Ans:

1) **Shunt magnet:** produce flux proportional to voltage of circuit and interact in the aluminum disc with flux produced by current magnet for torque production.
2) **Series magnet:** produce flux proportional to current (load current)of circuit and interact in the aluminum disc with flux produced by voltage magnet for torque production.
3) **Pressure coil:** produce flux proportional to voltage of circuit that interact in the aluminum disc with flux produced by current magnet for torque production
4) **Current coil: :** produce flux proportional to current (load current)of circuit that interact in the aluminum disc with flux produced by voltage magnet for torque production.
5) **Aluminum disc:** rotates under the influence of the fluxes produced by current & voltage magnet.
6) **Braking magnet:** brakes the motion of the aluminum disc or slows it down.
7) **Copper shading band:** splits the flux into two components differing in phase by about 40 to 50^{o}.
8) **Spindle:** carries the Al disc and is geared to the rotation registering mechanism
9) **Registering mechanism**: registers the no of rotations of the aluminum disc in proportion to the energy drawn.
10) **Jeweled bearing:** supports the spindle and the associated parts on it offering very low friction.

Any four parts 1 mark for each = 4 marks

5 c) Compare analog multi-meter with DMM on any four points.

5 c) Ans:

Sr No.	Analog multi-meter	DMM
1	Power supply is not required	Power supply is required
2	Less suffered from electric	More suffered from electric

½ marks

	noise	noise	each (any 8 points)
3	Less isolation problems.	More isolation problems.	
4	Less accuracy	High accuracy is obtained.	
5	Simple construction	Complicated construction	
6	Bigger in size	Smaller in size	
7	Many times O/P is ambiguous	An unambiguous reading is obtained.	
8	Better visual indication	Visual indication is not that much better.	
9	Less cost	More cost	

5 d) List any four measure blocks of LCR meter and write function of each.

5 d) Ans: LCR meter:

1) Oscillator: it produces the variable frequency as required for measurements.
2) Current to voltage converter (IVC): converts the input current from the unknown parameter (to be measured) to equivalent voltage for further measurement purpose.
3) Control Switches: to provide proper input to Average Voltage Detector (AVD) & the digital integrator unit.
4) Voltage Controlled Oscillator (VCO): They produce clock signal, which are locked in phase to the reference signal.
5) Phase Sensitive Detector (PSD): Detects the phase between the input signals.
6) Range Switch: Selects the proper range for measurements
7) LCR Function Switch: for measurement of inductance (L), Capacitance(C) & resistance(R) this Switch is used.
8) Display unit: Displays Quantity to be measured.

1 mark each any four blocks

5 e) With neat sketch explain working principle of earth tester.

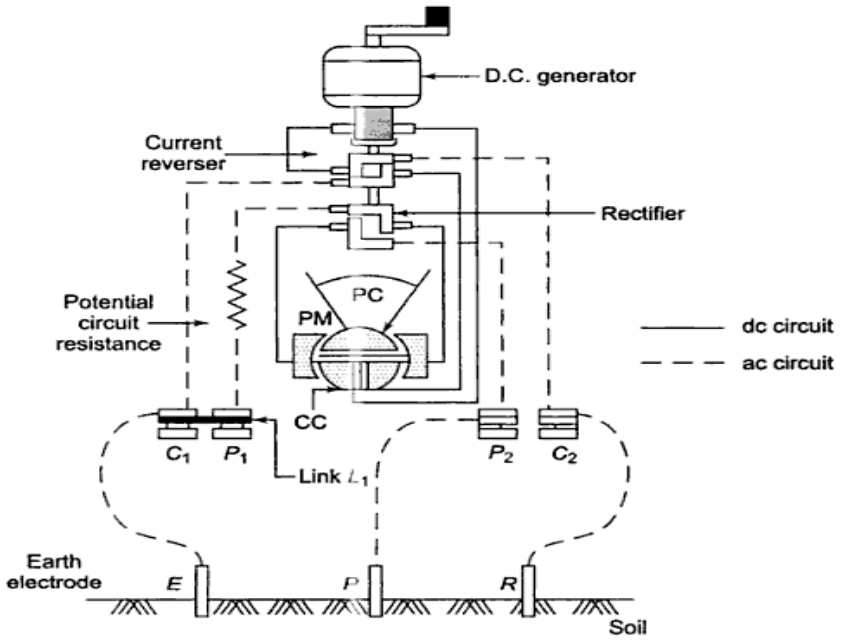
5 e) Ans:

Earth tester:-The resistance of the earth is measured with the help of earth tester. It consist 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. 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. 1 mark

Operation: - It is connected to earth whose resistance is to be measured, and the other spike P and R.

Diagram 2

marks



1 mark

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.

5 f) Draw a neat sketch of 1-Φ dynamometer type power factor meter. Label it.

5 f) Ans:

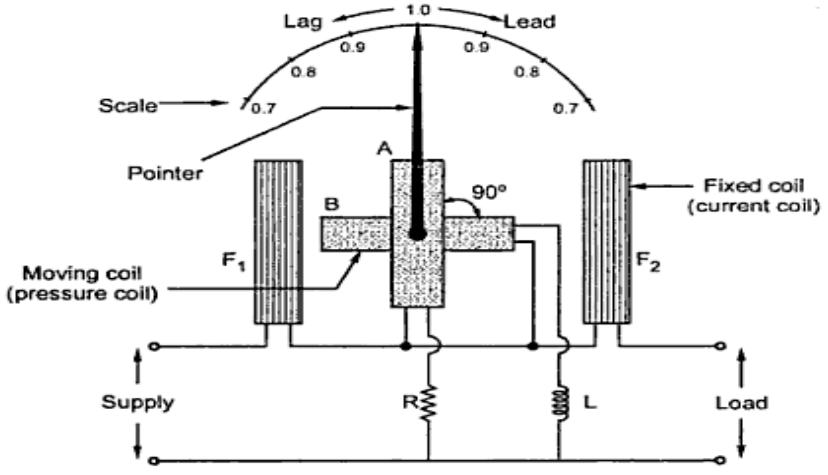


Diagram: labeled 4 marks, unlabeled 1 mark, partially labeled 2 marks.

Single phase electrodynamometer type power factor meter

6 Attempt any FOUR of the following: 16

6 a) PMMC instruments are used only for DC measurement. Explain.

6 a) Ans:

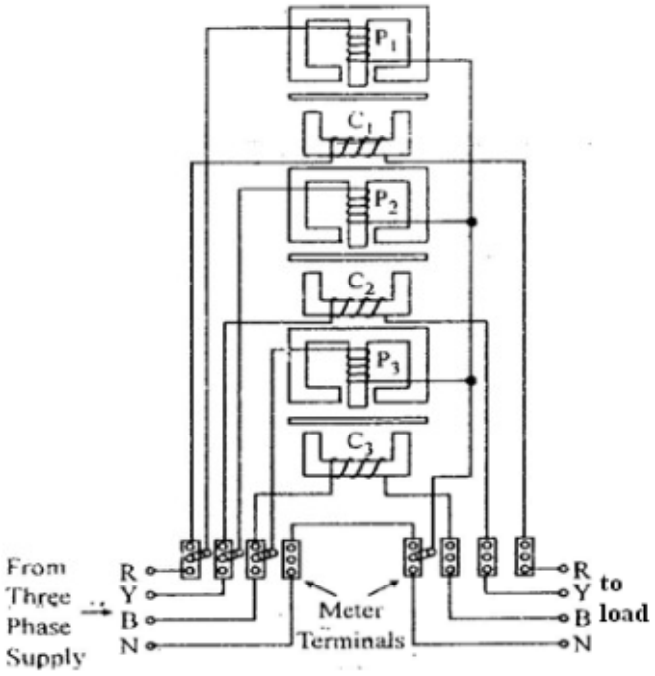
PMMC instruments are used only for DC measurement:

1. The direction of force exerted on moving coil depends on the direction of current flowing through moving coil.
2. If the direction of magnetic field kept constant it produces unidirectional torque. Thus the D.C. current is passed through the coil; unidirectional torque is created as the direction of current is constant.
3. But in case of A.C. the direction of current reverses in the positive and negative half cycle of A.C.
4. Hence force exerted on moving coil in positive half cycle acts in opposite direction that will be the coil in negative half cycle.
5. Making the average torque acting on the coil in one cycle to zero. Hence the meter can not read A.C. quantities.

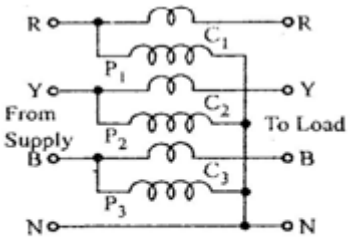
1 mark each point

6 b) Draw a neat sketch of induction type 3-Φ energy meter and label it.

6 b) Ans:



Three phase four wire induction type energy meter



Connection diagram

Fully labeled 4 marks, partial 1 to 3 marks proportional

6 c) Explain V-I methods of medium resistance measurement with neat circuit.

6 c) Ans:

Take reading of voltmeter and ammeter, then measured resistance = $R_m = V/I$ 1 mark

To minimise the error take 4 to 5 observation for the same resistance 1 mark

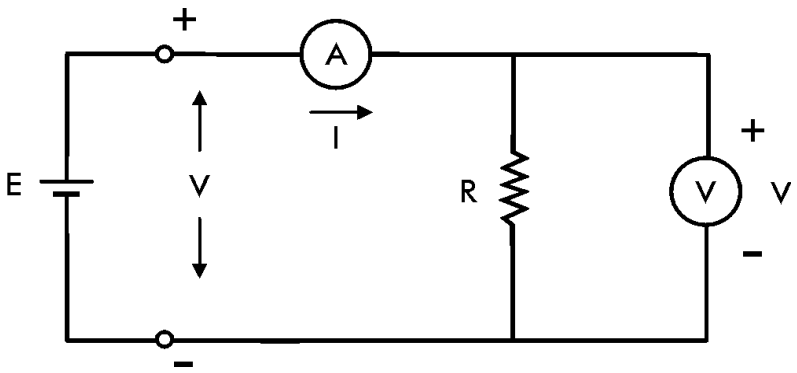


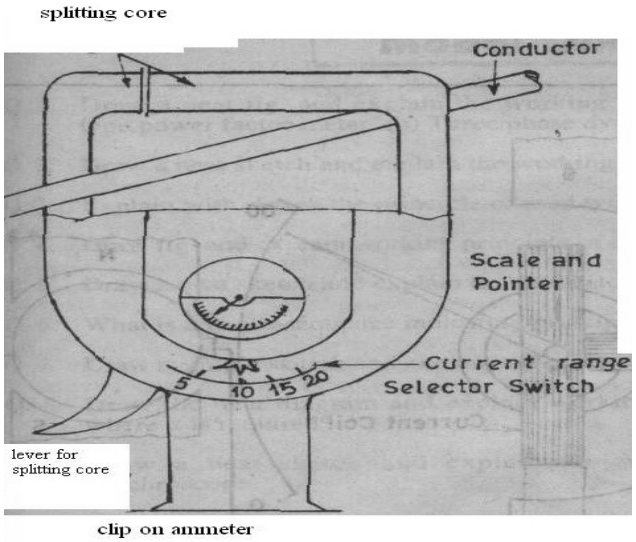
Figure or equivalent diagram 2 mark

6 d) With neat diagram explain working of clip on ammeter.

6 d) Ans:

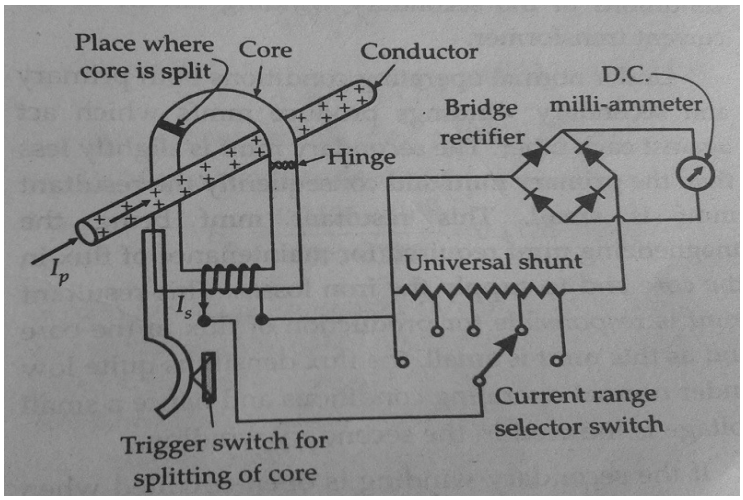
Clip on ammeters are used to measure the high current flowing through bus bar, cable or fuse holders carrying currents. They consist of split core current transformer whose secondary winding is connected to rectifier type moving coil instrument. The primary becomes conductor, whose current is to be measured. The split core gets aligned by the force of a spring tension. While the core is covered with insulating material. Hence higher current through conductors can be measured. 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 shown and then clipped over the conductor carrying current. The dial will record the current directly.

Description 2 marks



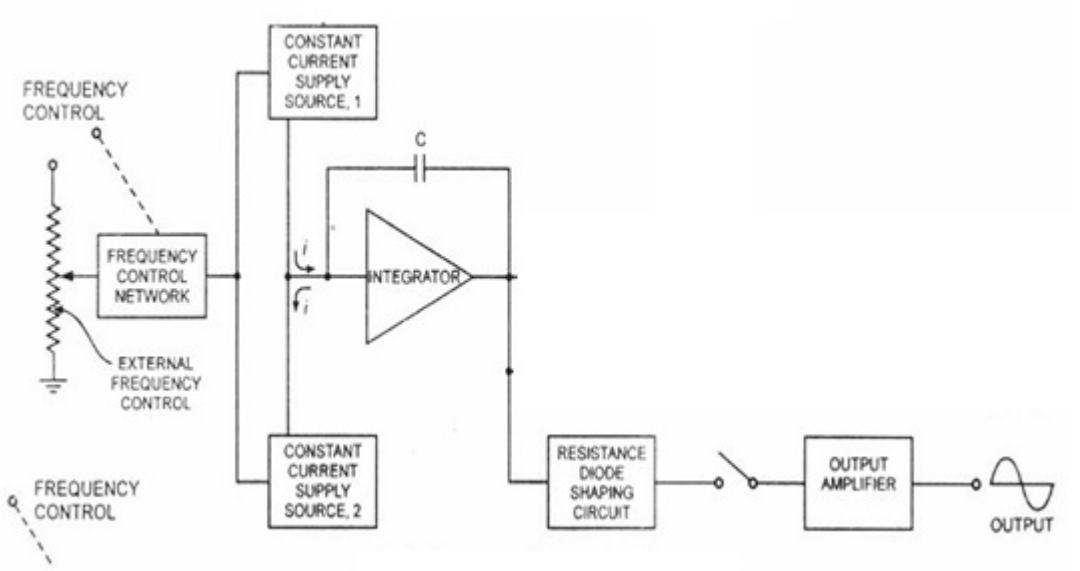
2 marks for any one diagram

OR



6 e) Draw a labeled block diagram of sine wave generator. State function of each block.

6 e) Ans:



2 marks

2 marks

Sine Wave Generator:

- This instrument delivers sine waves with frequency range of 0.01 Hz to 100 kHz.
- The frequency control network is governed by a frequency dial on the front panel of the instrument
- The frequency control voltage regulates two current sources.
- The upper current source supplies a constant current to the integrator whose

output voltage increases with time.

- The voltage comparator multi-vibrator changes state at a predetermined level on the positive slope of the integrator's output voltage.
- The lower current source supplies a reverse current to the integrator so that its output voltage reaches a predetermined level on the negative slope of the integrator's output voltage.

6 f) Write applications of CRO.

6 f) Ans:

Applications of CRO: 1 mark each any four points = 4 marks.

1) Measurement of phase and frequency.
2) Measurement of inductance and capacitance.
3) Tracing the waveform.
4) Determination of amplitude of variable quantity.
5) In radar & television.
6) For finding B-H curves.
7) For studying the heart beats etc.
8) To detect standing waves in transmission lines
9) To check faulty components in various circuits.
10) For tracing transistor curves.