Zeal Education Society's

ZEAL POLYTECHNIC, PUNE.

NARHE | PUNE -41 | INDIA

SECOND YEAR (SY)

DIPLOMA IN ELECTRICAL ENGINEERING

SCHEME: I SEMESTER: III

NAME OF SUBJECT: ELECTRICAL AND ELECTRONIC MEASUREMENT

Subject Code: 22325

MSBTE QUESTION PAPERS & MODEL ANSWERS

1. **MSBTE WINTER-18 EXAMINATION**
2. **MSBTE SUMMER-19 EXAMINATION**
3. **MSBTE WINTER-19 EXAMINATION**

22325

11920

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

(5) Use of Non-programmable Electronic Pocket Calculator is permissible.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) State the meaning of 'Absolute standard' and 'Secondary Standard'.

b) State the working principle of PMMC Analog instrument.

c) Calculate the resistance of shunt required to make a milliammeter which gives maximum deflection for a current of 15 mA and which has a resistance of 5Ω ; read upto 10 Amp.

d) State the purpose of four quadrant meter.

e) A single phase wattmeter rated for 500V; 5A is having full scale deflection of 1000 watt, What is multiplying factor of the wattmeter?

f) List the errors occurring in single phase electronic energy meter.

g) State the advantages of electronic energy meter.

Marks

2. Attempt any THREE of the following: **12**

a) Compare analog instrument to digital instrument on the basis of accuracy; resolution, power required and portability.

b) List the types of systematic errors and state the reasons due to which these errors occur.

c) State the purpose of calibration of measuring instruments. Explain the procedure of calibration of D.C.Voltmeter by using D.C. Potentiometer.

d) A permanent magnet moving coil instrument of full scale deflection of 25 mA when P.D. across its terminal is 75 mV Calculate.

(i) Resistance of shunt required for full scale deflection of 150 A

(ii) Series Resistance for full scale reading 500 volts.

3. Attempt any THREE of the following: **12**

a) Explain with neat sketch: the working of full-wave rectifier voltmeter.

b) Draw the circuit diagram for:-

(i) Measurement of active power in 3-phase load circuit using two wattmeter.

(ii) Measurement of reactive power in 3-phase load circuit using one wattmeter.

c) Explain the error occurred due to pressure coil inductance of electrodynamometer type wattmeter How this error is compensated?

d) Describe with block diagram; the construction of single phase Electronic Energy meter.

Marks

4. Attempt any THREE of the following: **12**

a) Draw a neat labeled block diagram of 3-phase Electronic Energy meter.

b) Describe with block diagram; the principle of operation of digital storage oscilloscope.

c) Describe with block diagram; the working of digital frequency meter.

d) Describe with suitable example; frequency measurement by Lissajous patterns on CRO.

e) Draw the block diagram of trivector meter. State the various measurements possible from trivector meter.

5. Attempt any TWO of the following: **12**

a) Explain with neat sketch; the construction and working principle of Repulsion type moving Iron instrument.

b) Explain the effect of power factor on wattmeter readings in two wattmeter method of power measurement.

c) Draw a block diagram of function generator and state the function of each block.

6. Attempt any TWO of the following: **12**

a) Explain the calibration of single phase electronic energymeter using direct loading.

b) Describe the procedure for the measurement of Earth resistance by using Earth tester.

c) Explain with neat sketch; the construction and working principle of Megger.

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC-27001-2013 Certified)

Winter – 2019 Examinations

Model Answers

Subject & Code: Electrical & Electronic Measurements (22325)

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.

Winter – 2019 Examinations

Model Answers

Subject & Code: Electrical & Electronic Measurements (22325)

1 Attempt any FIVE of the following: 10

1 a) State the meaning of 'Absolute standard' and 'Secondary standard'.

Ans:

Absolute Standard: An Absolute standard is the one that does not require any other reference for calibration. 1 Mark

Secondary Standard: The secondary standard is that which must be compared periodically to a reference i.e primary standard, depending on the accuracy required. 1 Mark

1 b) State the working principle of PMMC Analog instrument.

Ans:

Working Principal of PMMC Analog Instrument:

When current carrying conductor is placed in a magnetic field, it experiences mechanical force. 1 Mark

In PMMC instrument, when current flows through a coil placed in the gap between the poles, force is produced on the coil. The coil rotates and pointer attached to the coil shows deflection proportional to the current magnitude. 1 Mark

1 c) Calculate the resistance of shunt required to make a milliammeter which gives maximum deflection for a current of 15 mA and which has a resistance of 5 Ω; read up to 10 Amp.

Ans:

Given: Full scale deflection current I_G = 15 mA .

Resistance of moving coil instrument R_G = 5 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}, 1 Mark

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

$R_{sh} = I_G.R_G/(I - I_G) = 15 \times 10^{-3} \times 5/(10 - 15 \times 10^{-3})$

R_{sh} = 7.51 x 10^{-3} ohms 1 Mark

1 d) State the purpose of four quadrant meter.

Ans:

Purpose of four quadrant meter:

Four-quadrant meter is basically a bidirectional energy-meter with additional measurement facility. The purposes of four-quadrant meter are:

1) Measurement of energy/power under following conditions: 1 Mark for each of any two purposes = 2 Marks

Quadrant I: Import of active power and Import of lagging reactive power.
Both active & lagging reactive powers flow positively.
Both are delivered to the consumer load.

Quadrant II: Export of active power and Import of lagging reactive power.
The active power flow negatively & lagging reactive power flows positively. The active power is delivered to supply system.
The lagging reactive power is delivered to load.

Quadrant III: Export of active power and Export of lagging reactive power.
Both active & lagging reactive powers flow negatively.

Both active & lagging reactive powers are delivered to supply system.

Quadrant IV: Import of active power and Export of lagging reactive power.
The active power flows positively & lagging reactive powers flow negatively.
The active power is delivered to load & lagging reactive power is delivered to supply system.

2) Measurement of Maximum demand (MD) for each type of power i.e kW, kVA and kVARh

3) Time-of-use metering:
Bidirectional consumption and demand.

1 e) A single phase wattmeter rated for 500 V; 5A is having full scale deflection of 1000 watt. What is multiplying factor of the wattmeter?

Ans:

Multiplying factor = $\frac{Voltage\ Range \times Current\ Range \times PF}{FSD}$ — 1 Mark

Multiplying factor = $\frac{500 \times 5 \times 1}{1000} = 2.5$ (P.F is assumed as 1) — 1 Mark

1 f) List the errors occuring in single phase electronic energy meter.

Ans:

Errors in Single Phase Electronic Energy Meter:

1) Error due to wrong sensor opeartion.
2) Error due to temperature.
3) Error due to wrong CT opeartion.
4) Error due to wrong PT opeartion.
5) Error due to wrong opeartion of scaling network.
6) Error due to wrong ADC opeartion.
7) Error due to wrong Display.

1 Mark for each of any two errors = 2 Marks

OR Equivalent Answer

1 g) State the advantages of electronic energy meter.

Ans:

Advantages of Electronic Energy Meter:

1) Low cost.
2) High accuracy.
3) More flexibility.
4) High sensitivity
5) No frictional losses.
6) Less loading effect.
7) High frequency range.
8) Power consumption is less.
9) High resolution.
10) No requirement for external adjustment.
11) Low load, full load, power factor and creeping adjustments are not required.

1 Mark for each of any two advantages = 2 Marks

2 Attempt any THREE of the following: 12

2 a) Compare analog instrument to digital instrument on the basis of accuracy, resolution, power required and portability.

Ans:

Comparison between Analog instruments & Digital instruments:

Particulars	Analog Instruments	Digital Instruments
Accuracy	The accuracy of analog instrument is comparatively less. e.g Class 0.5, class 1	The accuracy of digital instrument is comparatively more. e.g Class 0.1
Resolution	The resolution of analog instruments is less.	The resolution of digital instruments is more.
Power required	More power is required for working of analog instruments.	Less power is required for working of digital instruments.
Portability	Analog instruments are extremely portable.	Digital instruments are not easily portable.

1 Mark for each point = 4 Marks

2 b) List the types of systematic errors and state the reasons due to which these errors occur.

Ans:

Systematic Error:

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

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.

2 Marks for errors

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

2 Marks for reasons

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

2 c) State the purpose of calibration of measuring instruments. Explain the procedure of calibration of D.C. voltmeter by using D.C. potentiometer.

Ans:

Purpose of calibration:

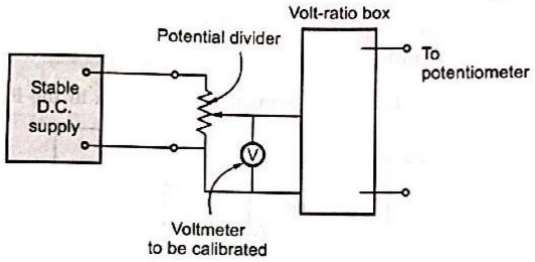
Calibration is the process of evaluating and adjusting the precision and accuracy of measuring equipment. Proper calibration of an instrument allows people to have a safe working environment and produce valid data for future reference.

1 Mark for purpose

- Precision is the degree to which repeated measurements under unchanged conditions show the same result
- Accuracy is the degree of closeness of measurements of a quantity to its actual true value.

For calibration, reference standards with known values for selected points covering the range of interest are measured with the instrument in question. Then a functional relationship in terms of error is established between the values of the standards (true value) and the corresponding measurements.

Calibration of D.C. voltmeter by using D.C. potentiometer:



1 Mark for diagram

For calibration of voltmeter using DC potentiomter, a volt-ratio box is required which consists of 50Ω to 100kΩ variable resistors and the arrangement steps down the input voltage so that it can be safely measured by DC potentiometer.

2 Marks for explanation

- Potentiometer is standardized before measurement.
- The circuit is connected as shown in the figure. With the help of potential divider the reading of voltmeter is set to the certain value.
- Let the reading of votlmeter is the measured voltage 'V_m' and the voltage measured by DC potentiometer is 'V_p'.
- The true value of the voltage 'V_t' is found out by multiplying the reading of potentiometer 'V_p' by corresponding ratio of the volt-ratio box.
- Calculate the relative error in the voltmeter for each reading.

$$\% \, error = \frac{(Measured\ value - true\ value)}{true\ value} \times 100 = \frac{V_m - V_t}{V_t} \times 100$$

- A calibration curve can be drawn by plotting the percentage error against the measured voltages.

2 d) A permanent magnet moving coil instrument gives full scale deflection of 25mA when a voltage of 75mV is applied across it. Calculate:

(i) Resistance of shunt required for full scale deflection of 150 A.
(ii) Series resistance for full scale deflection of 500 V.

Ans:

Given:

Full scale deflection current $I_m = 25mA = 25 \times 10^{-3}$ A
Required full scale deflection current I = 150 A.
Full scale deflection Voltage $V_m = 75$ mV $= 75 \times 10^{-3}$ V
Required full scale deflection Voltage V = 500 V.

Shunt resistance R_{sh} :

$R_m = V_m / I_m = 75 \times 10^{-3} / 25 \times 10^{-3}$ — 1 Mark
$= 3\ \Omega$

Now, $\mathbf{R_{sh}} = I_m.R_m / (I - I_m)$ — ½ Mark
$= 25 \times 10^{-3} \times 3 / (150 - 25 \times 10^{-3})$
$= 0.075 / 149.975$ — 1 Mark

= **0.0005 Ω**

Series Resistance R_{se}:

$R_{se} = (V / I_m) - R_m$ ½ Mark

$= (500 / 25 \times 10^{-3}) - 3$

$= 20000 - 3$ 1 Mark

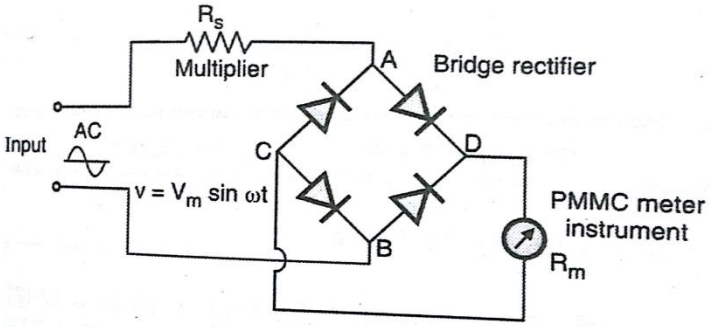
= **19997 Ω**

3 Attempt any THREE of the following: 12

3 a) Explain with neat sketch, the working of full wave rectifier voltmeter.

Ans:

Full Wave Rectifier Type Voltmeter:



2 Marks for Diagram

Working of full wave rectifier type A. C. Voltmeter

Referring to the circuit diagram, for rectification, a full wave bridge circuit (ABCD) is used. Input is given across A and B in series with R_S (multiplier). Ultimately d.c. is available as output voltage from points C and D to which PMMC meter is connected. Now the current passing through meter is given as, $I_M = \frac{Vdc}{Rm+Rs}$ which causes full scale deflection of the meter.

2 Marks for Working

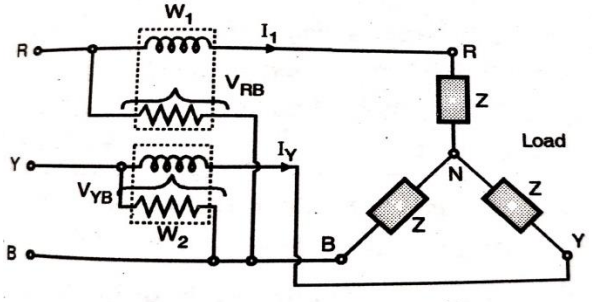
3 b) Draw the circuit diagram for:-

i) Measurement of active power in 3-phase load circuit using two wattmeter.

ii) Measurement of reactive power in 3-phase load circuit using one wattmeter.

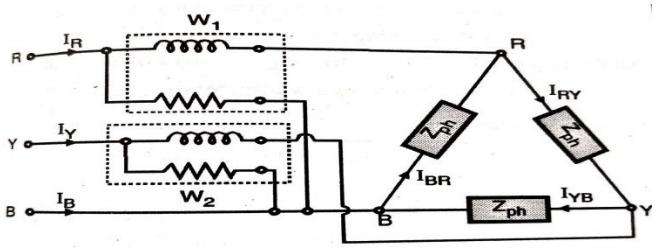
Ans:

(i) Measurement of active power in 3- phase load circuit using two- wattmeter:

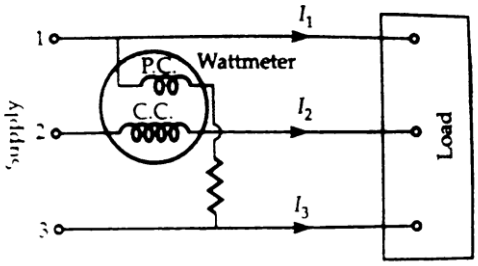


2 Marks for labeled circuit diagram

OR



(ii) Measurement of reactive power in 3- phase load circuit using one wattmeter

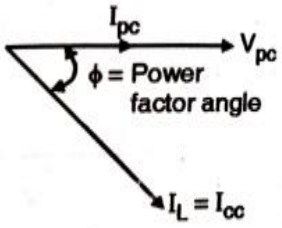


2 Marks for labeled circuit diagram

3 c) Explain the error occurred due to pressure coil inductance of electrodynamometer type wattmeter. How this error is compensated?

Ans:

For power measurement assume that the pressure coil of wattmeter is purely restitive. Hence current taken by pressure coil I_{pc} is in phase with voltage across the pressure coil V_{pc}



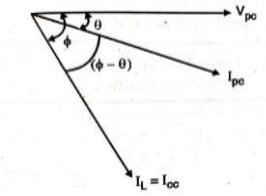
2 Marks for error

Depending upon the power factor of connected load, current coil takes current, I_{cc} at appropriate phase angle with respect to the load voltage (Pressure coil voltage) V_{pc}. For inductive load, power factor is lagging. Therefore wattmeter reading is equal to

$$W = V_{pc} I_{pc} \cos \phi$$

But in practical cases, the pressure coil possesses small inductance. Due to this, I_{pc} lags behind V_{pc} by small angle θ. Therefore wattmeter reading is equal to

$$W = V_{pc} I_{pc} \cos (\phi - \theta)$$



The phase difference between I_{cc} and I_{pc} decreases and $\cos(\phi - \theta)$ increases .

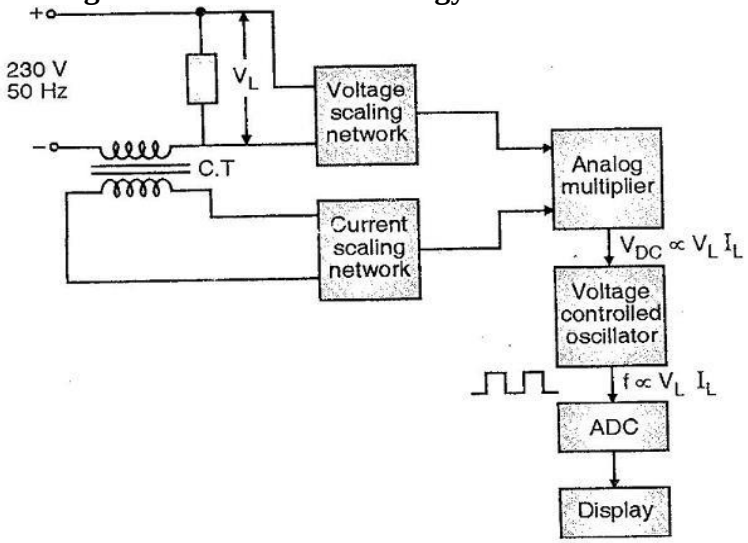
Hence the wattmeter reads more power than the actual power consumed by the load.
The error occurred due to pressure coil inductance of electrodynamometer type wattmeter can be compensated as follows:
To reduce this error, capacitance is connected in parellel with pressure coil of the wattmeter. By making the value of capacitive reactance X_c equal to inductive reactance X_L the pressure coil circuit is made purely resistive and the error is eliminated.

2 Marks for compensation

3 d) Describe with block diagram; the construction of single phase electronic energy meter.

Ans:

Construction of Single Phase Electronic Energy Meter:



2 Marks for Diagram

OR Any other equivalent layout diagram

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

2 Marks for Description

4 Attempt any THREE of the following: 12

Winter – 2019 Examinations

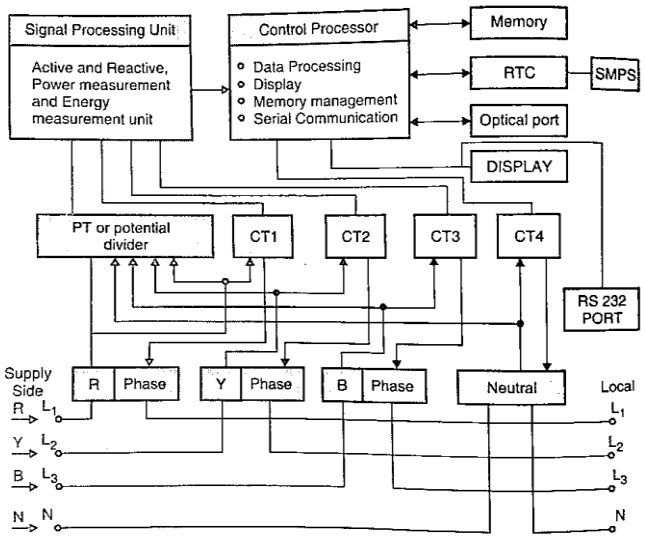
Model Answers

Subject & Code: Electrical & Electronic Measurements (22325)

4 a) Draw a neat labeled block diagram of 3-phase Electronic Energy meter.

Ans:

Labeled diagram of 3-phase electronic energy meter:



OR Any other equivalent diagram

4 marks for labeled diagram,

3 marks for partially labeled diagram,

2 marks for unlabeled diagram

4 b) Describe with block diagram; the principle of operation of digital storage oscilloscope.

Ans:

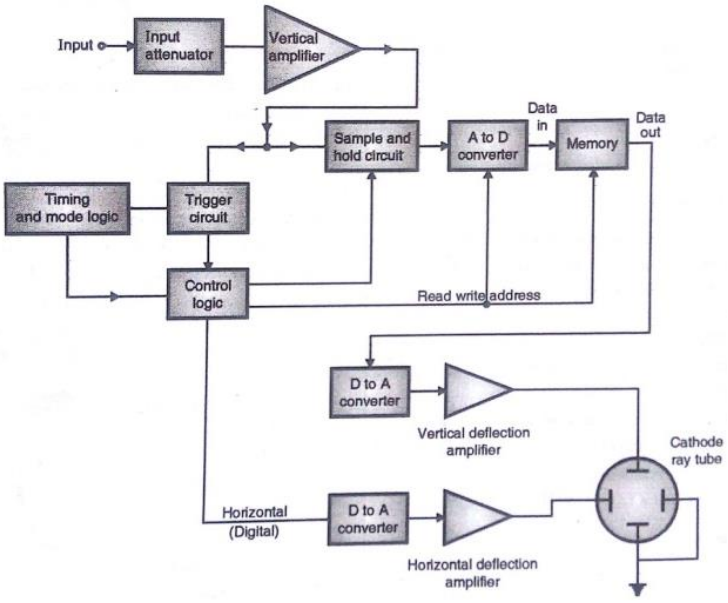


Fig: Block diagram of digital storage oscilloscope OR Any equivalent diagram

2 Marks for block diagram

The block diagram of DSO is shown above. Sampling rate may be as high as 1,00,000 samples per sencod. For such high sampling rates, a fast conversion ADC is requried. Flash ADC convertor are used at the cost of decresed resolution with increase in sampling rate.

The memory size is related to the amount of horizontal segment of the trace that can be

2 Marks for description

divided into one sweep of the time base.
If the 10 bit ADC is used then the frequency response of 25khz is obtained.The total memory storage capacity is 4096 for single channel, 2048 for two channels and 1024 for 4 channels each.
The selection of sampling rate and memory size depends on the type of waveform being recorded.
A continuous storage oscilloscope consist of feature called "Pre-Trigger view".
This mode is useful when failure occurred.
The DSO has three modes of Operation:

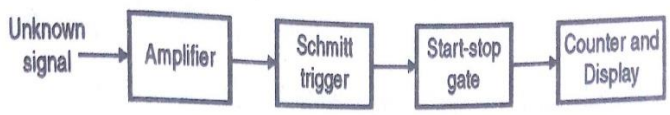
i) Roll mode
ii) Store mode
iii) Hold or save mode

i) **Roll mode :**This mode is used to observe the fast varying signal.In this mode input signal is not trigger at all.The stored signal is rolled across the screen from right to left.
ii) **Store mode:**This mode is most commonly used it called as refresh mode.Once trigger pulse is obtained the memory write cycle is initiated ADC converts input signal to digital code and fed to memory.When memory is full the memory write cycle stops.The digitally stored signal is converted back to the analog using DAC.When the next trigger is received , the memory is refreshed with the next signal.
iii) **Hold and save mode:**The modern DSO operate on automatic refresh system.When a new sweep signal from the time base circuit is received. Then the new contents are over written on the old contents.If it is required to retain the particular signal in the memory then overwritting should be stopped.This obtained by using Hold and Save button.

4 c) Describe with block diagram the working of digital frequency meter.

Ans:

Digital frequency meter:



1 Mark for Diagram

Fig: Block diagram of digital frequency meter OR Any equivalent diagram

Amplifier:
The signal whose frequency is to be measured is first amplified and supplied to the schmitt trigger.

Schmitt Trigger:
The schmitt trigger convert the signal into square wave having fast rise and fall time.The square wave is then differentiated and clipped. Each pulse is proportional to each cycle of unknown signal

3 Marks for explanation

Start – Stop gate:
When the gate is open input pulses are allowed to pass through it.The counter is now

start counting the pulses.
When gate is closed input pulses are not allowed to pass through it.The counter is now stop counting the pulses.

Counter and display:

The number of pulses during the period gate is open are counted by counter.If the interval between start and stop condition is known the freuency of unknown signal is measured.

$$F = \frac{N}{t}$$

Where, F = unknown frequency
N = No. count displayed on counter
t = time interval between start and stop condition of the gate

4 d) Describe with suitable example; frequency measurement by Lissajous patterns on CRO.

Ans:

- Initially the unknown frequency signal is connected to vertical deflection plates of CRO.
- Now switch of the internal sweep generator of the horizontal deflecting system.
- A standard source of frequency is applied to the horizontal deflection plates.
- The frequency of standard source is adjusted now until a circular or elliptical pattern appears on CRT screen.
- When such pattern is observed on a screen, it indicates that two frequencies are equal.
- Practically, it is not possible to adjust the standard frequency exactly equal to unknown frequency. Hence the standard frequency is adjusted to be a multiple or submultiple of unknown frequency.

2 Marks for description

Vertical input Frequency measurement by Lissajous patterns on CRO can be explain by following example:

Assume horizontal input frequency is 10 kHz for following pattern

2 Marks for any one suitable example

Fig: Lissajous patterns observed on CRO

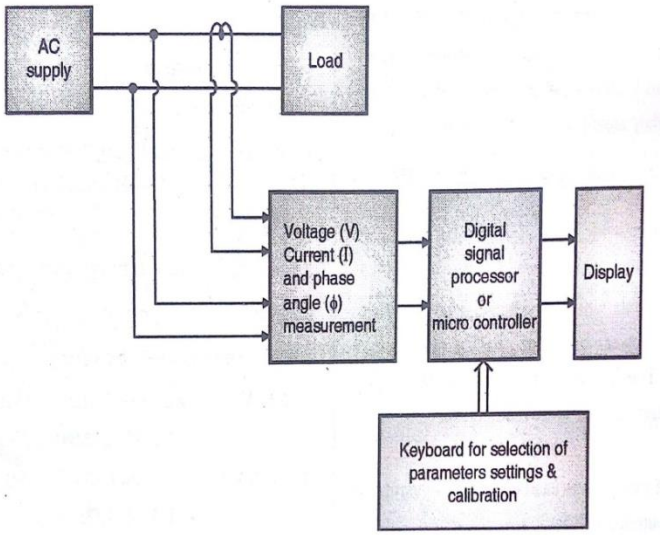
$$\text{Vertical input Frequency} = \frac{Number\ of\ Horizontal\ tangencies}{Number\ of\ vertical\ tangencies}\ x\ Horizontal\ input\ frequency$$

$$= \frac{3}{1} \times 10\ kHz$$

Vertical input Frequency = 30 kHz.

4 e) Draw the block diagram of tri-vector meter. State the various measurements possible from tri-vector meter.

Ans:



2 Marks for Diagram

Fig: Block diagram of tri-vector meter

OR Any euivalent diagram

Various measurements possible from tri-vector meter are:

2 Marks for quantities

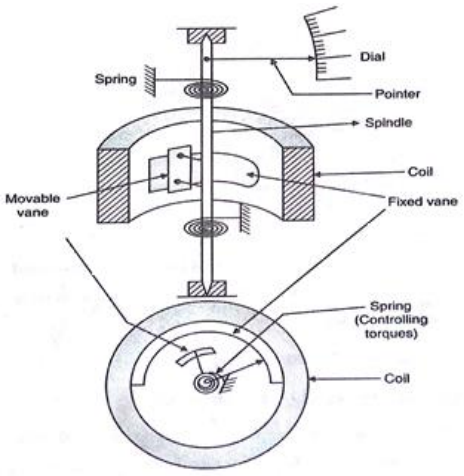
Tri-vector meter is a measuring instrument which measures the kWh, kVArh, the kVAh of a power line. Tri-vector meter is an energy meter which accurately measures all the parameters of supply such as voltage, current, power factor, active load, reactive load, apparent load etc.

5 Attempt any TWO of the following: 12

5 a) Explain with neat sketch; the construction and working principle of Repulsion type moving iron instrument**.**

Ans:

Repulsion Type Moving Iron Instrument:



3 Marks for Diagram

Construction:

2 Mark for construction

It consist of fixed cylinder hollow coil which carries operating current inside the coil there are two soft iron pieces. One of which is fixed other is movable. The fixed iron piece is attached to the coil whereas the movable iron piece is attached to the pointer.

Under the action of deflecting torque the pointer attached to the moving system moves over the scale. The controlling torque is provided by spring control and damping torque is provided by air friction.

Working Principle: 1 Mark for principle

When two iron pieces are magnetized with same polarity a repulsive force act on them and moving iron piece gets deflected.

5 b) Explain the effect of power factor on wattmeter reading in two wattmeter method for power measurement.

Ans:

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

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

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

We will consider following cases of power factors

1. If power factor is unity i.e. p.f.=1 (ø=0)

$W_1 = V I \cos(30° + 0)$ and $W_2 = V I \cos(30° - 0)$

$W_1 = V I \cos 30°$ and also $W_2 = V I \cos 30°$ 2 Marks

Thus both the wattmeter reads equal readings and each wattmeter reads half of the total power

2. If power factor is 0.5 i.e. ø = 60°

$W_1 = V I \cos(30° + 60°)$ and $W_2 = V I \cos(30° - 60°)$

$W_1 = VI\cos(90°) = 0$ and $W_2 = V I \cos(-30°) = 0.866\ VI$ 2 Marks

Thus one wattmeter reads zero and other one shows positive reading.

3. If power factor is 0 i.e. ø =90°

$W_1 = V I \cos(30° + 90°)$ and $W_2 = V I \cos(30° - 90°)$

$W_1 = V I \cos 120°$ and $W_2 = V I \cos(-60°)$ 2 Marks

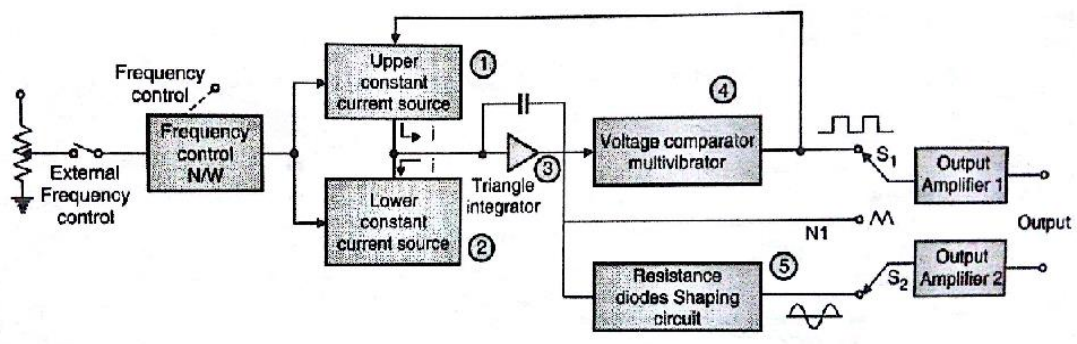
$W_1 = -0.5\ VI$ and $W_2 = 0.5 V I$

Thus both the wattmeter reads equal but opposite power.

5 c) Draw block diagram of function generator and state the function of each block.

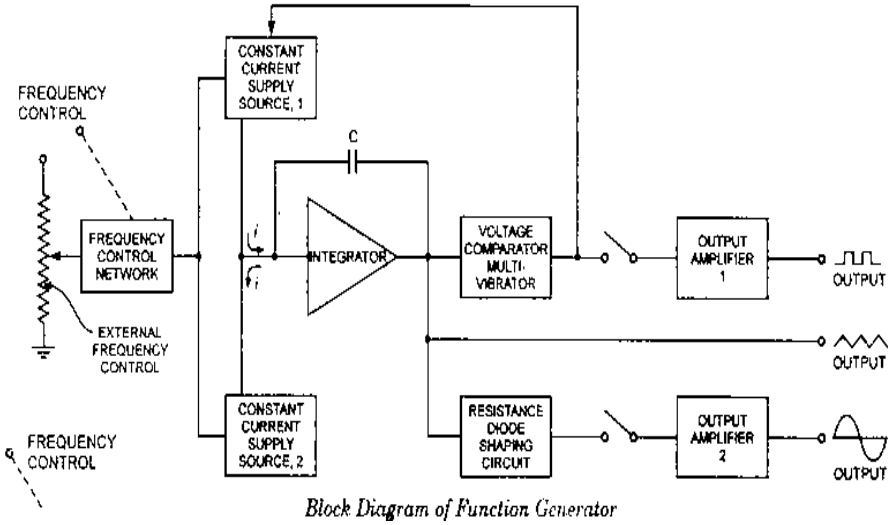
Ans:

Block Diagram of Function Generator:



3 Marks for Diagram

OR



Block Diagram of Function Generator

Working of Function Generator :

- This instrument can deliver sine, triangular & square 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.
- 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.

3 Marks for functions

6 Attempt any TWO of the following: 12

6 a) Explain the calibration of single phase electronic energy meter using direct loading.

Ans:

Calibration of Single-phase Electronic Energy Meter by Direct Loading Method:

The following figure shows the arrangement of calibration for single phase electronic energy meter. A phase shifter is connected for changing power factor of circuit.

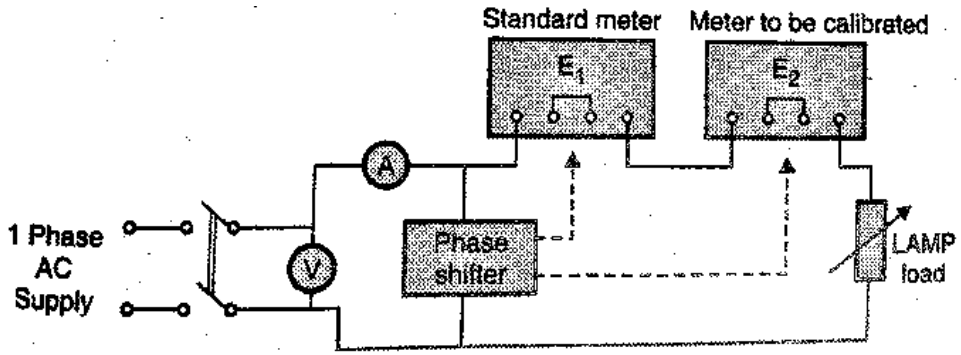
The energy readings are taken for different values of current at different power factors.

Let D = Registration of meter under calibration in kWh &

Ds = Registration of standard meter in kWh

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

3 Marks for explanation

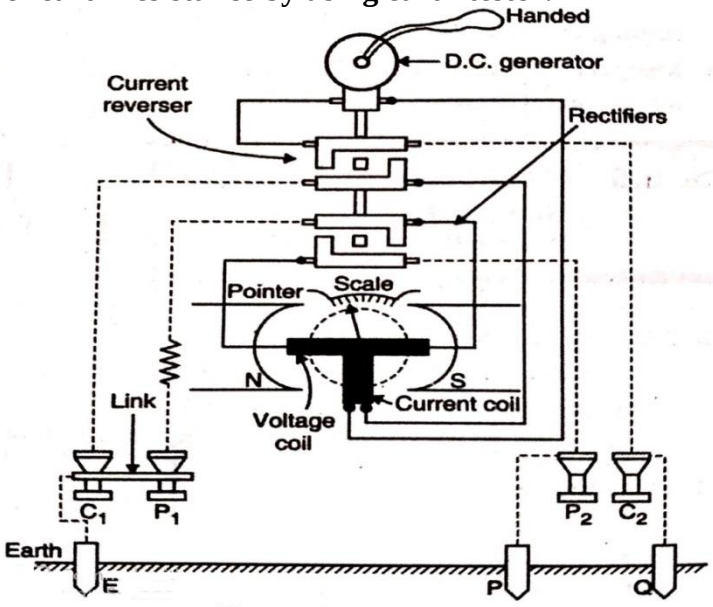


3 Marks for circuit diagram

6 b) Describe the procedure for the measurement of earth resistance by using earth tester.

Ans:

Measurement of earth resistance by using earth tester:



3 Marks for labeled Diagram

- It is connected to earth electrode E, whose resistance is to be measured, and the other spike P and R, as shown in the figure.
- 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 electrode under test.

3 Marks for procedure

6 c) Explain with neat sketch the construction and working principle of megger.

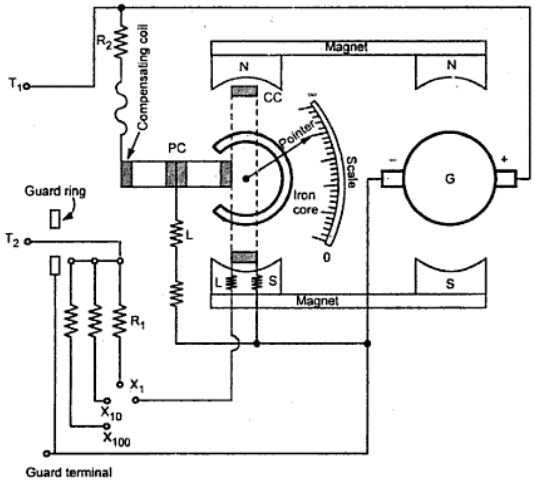
Ans:

Megger:

Winter – 2019 Examinations

Model Answers

Subject & Code: Electrical & Electronic Measurements (22325)



3 Marks for diagram

Construction of 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 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 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, 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.

2 Marks for construction

Working principle of Megger:

It works on the principle of electromagnetic attraction. When a current-carrying primary coil is placed under the influence of a magnetic field it experiences a force. This force produces a torque that is used to deflect the pointer of the device which gives some reading**.**

1 Mark for working principle

22325

11819

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Answer each next main question on a new page.

(3) Illustrate your answers with neat sketches wherever necessary.

(4) Figures to the right indicate full marks.

(5) Assume suitable data, if necessary.

Marks

1. Attempt any FIVE of the following: **10**

a) State the necessity of measurement necessity?

b) State the meaning of the following:

(i) Sensitivity

(ii) Deflecting torque

c) State the full form of PMMC and PMMI.

d) Represent the vector representation of power triangle.

e) State the types of errors (Any four).

f) State the meaning of CT's.

g) List differences between absolute and secondary instrument.

Marks

2. Attempt any THREE of the following: **12**

a) State the desirable qualities of measuring instrument and explain any two in brief.

b) With neat sketch of PMMC instrument explain its working briefly.

c) List out comaprisions between CT's and PT's (Any four).

d) State errors occurring in measurement of electrical power.

3. Attempt any THREE of the following: **12**

a) A moving coil instrument gives full scale deflection of 24 mA. When a P.D. across if is 108 mV. Find the value of –

(i) Series resistance for full scale deflection of 400 V.

(ii) Find the power consumption.

b) Explain the working of single phase electronic energy meter with sketch.

c) State the merits and demerits of power measurement using 2-wattmeter method.

d) With the neat sketch explain working of Dynamometer type wattmeter.

4. Attempt any THREE of the following: **12**

a) Draw a neat labelled diagram of 3-phase electronic energy meter.

b) State and explain working of phase sequence indicator with suitable sketch.

c) State/Describe the construction and working of western type frequency meter with labelled diagram.

d) State the differences between analog instruments and digital instruments.

e) State the necessity and construction of earth tester with suitable sketch.

Marks

5. Attempt any TWO of the following: **12**

a) Three identical coils each of (4 + j5) Ω are connected in S far across 415V, 3-phase 50 Hz supply find

(i) V_{ph}

(ii) I_{ph}

(iii) Wattmeter readings W_1, W_2.

b) Describe with sketches the various blocks and working of signal generator.

c) State the necessity of synchroscope and with neat sketch explain its working.

6. Attempt any TWO of the following: **12**

a) Draw the neat labelled diagram showing the controls available on front panel of CRO.

b) State the necessity of extension of Ammeter using shunt with mathematical derivation if necessary.

c) State errors occurring in wattmeter and suggest method for overcoming such types of errors (Any six).

———

Winter – 2018 Examinations

Model Answers

Subject & Code: Electrical & Electronic Measurements (22325)

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.

Winter – 2018 Examinations

Model Answers

Subject & Code: Electrical & Electronic Measurements (22325)

1 Attempt any FIVE of the following: 10

1 a) State the necessity of measurement ~~necessity?~~

Ans:

Necessity of measurement:

Measurement is quantitative comparison between a known quantity and an unknown quantity. The in-depth knowledge of any parameter can be easily understood by the measurement and further modifications can also be done.

Measuring is basically used to monitor a process or operation as well as for control. The primary purpose of measurement in process industries and industrial manufacturing is to aid in the economics of industrial operation by improving product quality and efficiency. — 2 marks

Through measurement process, unknown quantity is compared with predetermined standard values and one can convert physical parameter to meaningful quantity.

OR any equivalent answer

1 b) State the meaning of the following:

(i) Sensitivity

(ii) Deflecting torque

Ans:

i) Sensitivity: It is the ratio of output response to the specified change in the input quantity being measured. — 1 mark

ii) Deflecting torque: The torque which causes the moving system (and hence the pointer attached to it) to move from zero position to indicate the electrical quantity being measured. — 1 mark

1 c) State the full form of PMMC and PMMI.

Ans:

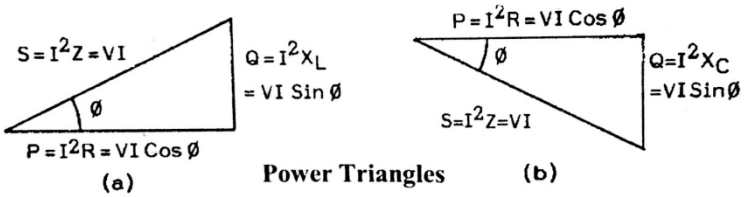
PMMC: Permanent Magnet Moving Coil. — 1 mark

PMMI : Permanent Magnet Moving Iron. — 1 mark

1 d) Represent the vector representation of power triangle.

Ans:

Vector representation of power triangle:



Power Triangles

Any one diagram 2 marks

1 e) State the types of errors (Any four).

Ans:

Types of errors in measuring instruments: — ½ mark for each error = 2 marks

i) Gross errors

ii) Systematic errors

a) Instrumental errors

b) Environmental errors

c) Observational errors
iv)Random errors

1 f) State the meaning of CTs
Ans:
Meaning of CTs: 2 marks
The meaning of CT is Current Transformer.

1 g) List differences between absolute and secondary instrument.
Ans:
Differences between absolute and secondary instrument:

Absolute Instrument	Secondary Instrument
1. These give magnitude of quantity in terms physical constants of instruments.	1. These give reading directly of the quantity at the time of measurement.
2. Calibration is not required.	2. Calibration with absolute instruments is required time to time as per requirements.
3. Measurement process is of time consuming.	3. Measurement is quick because of direct measurement.
4. Very rarely used in practical applications.	4. Very widely used in practical applications.
5. Absolute instruments are used in laboratories as standardizing instruments.	5. Secondary instruments are used in day to day work.
6. Example – Tangent Galvanometer.	6. Examples – Ammeter, Voltmeter, etc.

1mark for each of any two differences = 2 marks

2 Attempt any <u>THREE</u> of the following: **12**

2 a) State the desirable qualities of measuring instrument and explain any two in brief.
Ans:
Desirable qualities of measuring instrument:
(i)Accuracy (ii) Sensitivity (iii) Precision (iv) Repeatability (v) Drift (vi) Resolution (vii) Dead zone (viii) Back lash 1 mark

(i) Accuracy: It is the closeness with which an instrument reading approaches the true value of the quantity under measurement. The accuracy of a measurement means conformity to truth.

(ii) Sensitivity: It is the ratio of output response to the specified change in the input quantity being measured. The instrument must be moderately sensitive.

(iii) Precision: It is a measure of consistency or repeatability of measurements. It is also known as the degree of exactness for which an instrument is designed or intended to perform.

(iv) Repeatability: It is defined as the closeness among a number of consecutive measurements of the output for the same value of input, under the same operating conditions.

(v) Drift: It is gradual variation in output over a period of time i.e. independent to

1½ mark for each of any two desirable qualities explanation = 3marks

change in output operating conditions.

(vi) Resolution: Resolution is the least incremental value at input or output that can be discriminated / detected by the measuring device.

(vii) Dead Zone: It is maximum values of a quantity under measurement to which the instrument does not respond.

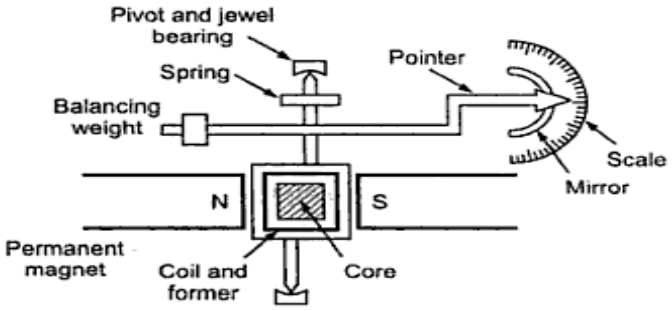
(viii) Back lash: It is a loss of motion in mechanical elements such as gears, linkages etc which are used for transmission of motion.

OR any equivalent answer

2 b) With neat sketch of PMMC instrument explain its working briefly.

Ans:

Diagram of PMMC instrument:



2 marks for labeled diagram,

OR any equivalent diagram

Working: When the instrument is connected in the circuit to measure current or voltage, the operating current flows through the coil. The coil is carrying current and is placed in the magnetic field of the permanent magnet, mechanical torque acts on it. The pointer attached to the moving system moves in a clockwise direction over the graduated scale to indicate the value of current or voltage being measured. If the current in the coil is reversed, the deflecting torque will also be reversed as a direction of field is same hence the pointer will move in opposite direction, So these instruments works only when current in the circuit is passing through in desired direction only. Hence they are used for DC measurements and not for AC measurements.

2 marks for working

2 c) List out comparisons between CTs and PTs (Any four).

Ans:

Comparison between CTs and PTs:

Sr. No.	CT	PT
1	CT corresponds to current transformer	PT corresponds to potential transformer
2	CT is basically a step-up transformer.	PT is basically step-down transformer.
3	Secondary winding is never open circuited when primary carries current.	No such restriction are there with PT.

Any four points = 4 marks

4	Used for range extension of ammeter.	Used for range extension of voltmeter.
5	Specified by their burden and nominal current ratio.	Specified by their burden and nominal voltage ratio.
6	Used for current measurement applications.	Used for voltage measurement applications.

2 d) State errors occurring in measurement of electrical power.

Ans:

Errors occurring in measurement of electrical power:

i) Error due to Method of connection.
ii) Error due to Pressure coil inductance.
iii) Error due to Pressure coil capacitance.
iv) Error due to mutual inductance effect.
v) Error due to Eddy currents.
vi) Stray magnetic field error.
vii) Error caused by vibration of the moving system.
viii) Temperature error.
ix) Error due to friction.
x) Gross errors
xi) Systematic errors
  a) Instrumental errors
  b) Environmental errors
  c) Observational errors
xii) Random errors

1 mark for each of any four = 4 marks

3 Attempt any THREE of the following: 12

3 a) A moving coil instrument gives full scale deflection of 24mA. When P. D. across ~~if~~ it is 108 mV. Find the value of –

(i) Series resistance of full scale deflection of 400V.
(ii) Find the power consumption.

Ans-

Given: -

I_V = Full scale deflection current through the instrument = 24mA
V = Voltage to be recorded = 400 V
P.D. = 108 m V

1) Step I – Calculation for internal resistance (R_v)

$$R_V = \frac{P.D.}{I_V} = \frac{108\times10^{-3}}{24\times10^{-3}} = 4.5\Omega$$

1 mark

2) Step II - Calculation for series resistance (R_m)

$$R_m = \frac{V}{I_V} - R_V$$
$$= \frac{400}{24\times10^{-3}} - 4.5$$
$$R_m = 16662.16\Omega \quad \text{or} \quad R_m = 16.662K\Omega$$

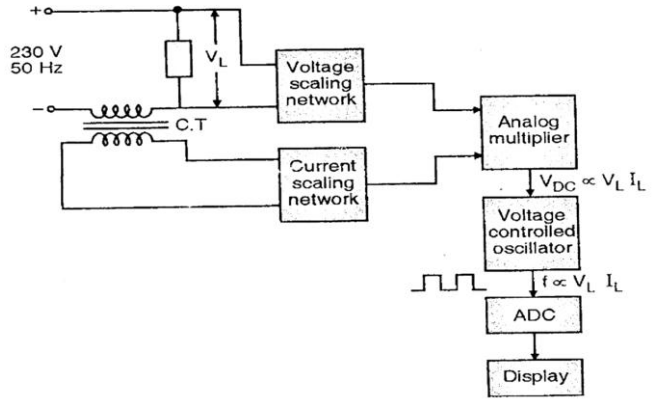
1 mark

3) Step III - Calculation for total resistance (R_T)

$R_T = R_m + R_v$
$= 16666.667 + 4.5$
$R_T = 16666.667\ \Omega$

4) Step IV - Calculation for power consumption — 1 mark
$P = I^2 R_T$
$= (24 \times 10^{-3})^2 \times 16666.667$ — 1 mark
$= 9.599$ Watts

3 b) Explain the working of single phase electronic energy meter with sketch.
Ans:



2 marks for diagram

OR Any other equivalent layout diagram

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

2 marks for working

3 c) State the merits and demerits of power measurement using 2-wattmeter method.
Ans:
Merits of power measurement using 2-wattmwter:
i) It is used for balanced as well as unbalanced load.
ii) For the star type load connection, it is not necessary to connect the neutral point.
iii)Delta load need not to be opened to connect the wattmeter.
iv) For balanced loads, it possible to measure power factor along with the power.
v) Only two watt-meters are required to measure the power in three phase circuits rather than three wattmeters.
vi) It is also possible to measure reactive power for balanced loads.

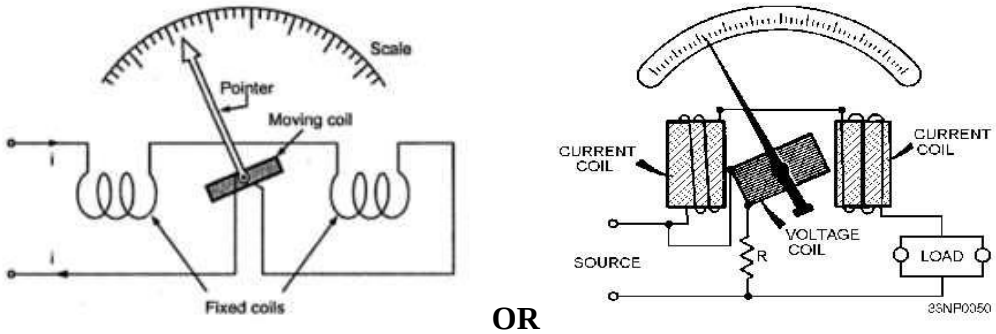
(2 marks for any two merits)

Demerits of power measurement using 2-wattmwter:
i) Two watt-meters are required.
ii) Not economical as compared to one wattmeter method.
iii) The connections of two wattmeter method are complicated than one wattmeter

(2 marks for any two demerits)

method.
iv) One of the wattmeter may read negative reading hence error may occur.

3 d) **With the neat sketch explain working of Dynamometer type wattmeter.**
Ans:



2 marks for any one diagram

OR

OR Any other equivalent diagram

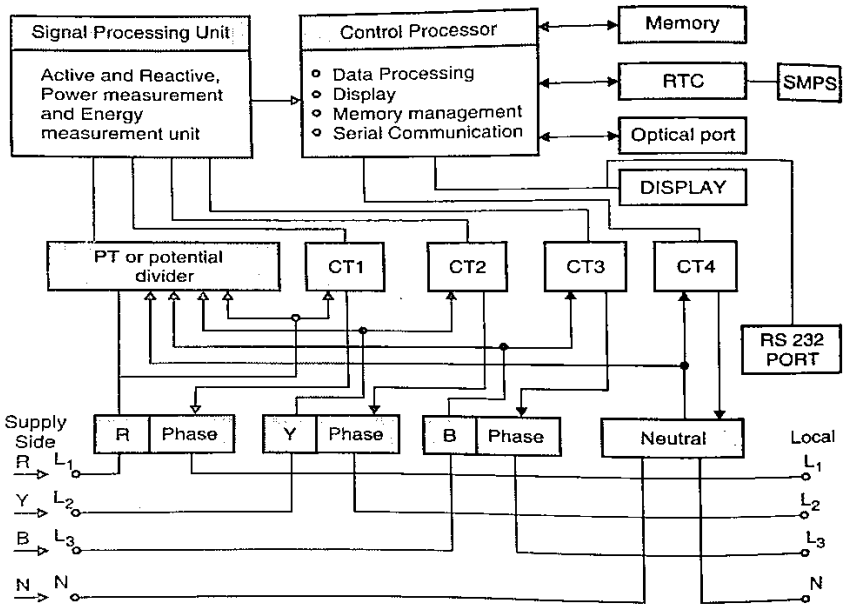
Working of Dynamometer type wattmeter:

When the instrument is connected in the circuit to measure power then current coil carries load current and potential coil carries current proportional to load voltage. Due to this mechanical force exerts between the coils. The result is that moving coil moves the pointer over the scale to give reading. When direction of current reverses, then it reverses the direction of current of fixed as well as moving coil so that the direction of deflecting torque remains unchanged hence these instruments can be used for measurement of A.C. & D.C. power.

2 marks for working

4 Attempt any THREE of the following: 12

4 a) Draw a neat labeled diagram of 3- phase electronic energy meter.
Ans:
Labeled diagram of 3- phase electronic energy meter:



4 marks for labeled diagram,

3 marks for partially labeled diagram,

2 marks for unlabeled diagram

OR Any other equivalent diagram

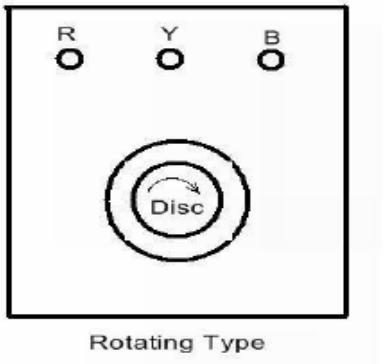
4 b) State and explain working of phase sequence indicator with suitable sketch.

Ans:

There are two types of phase sequence indicators and they are:

(a) Rotating type (b) Static type.

a) Rotating type



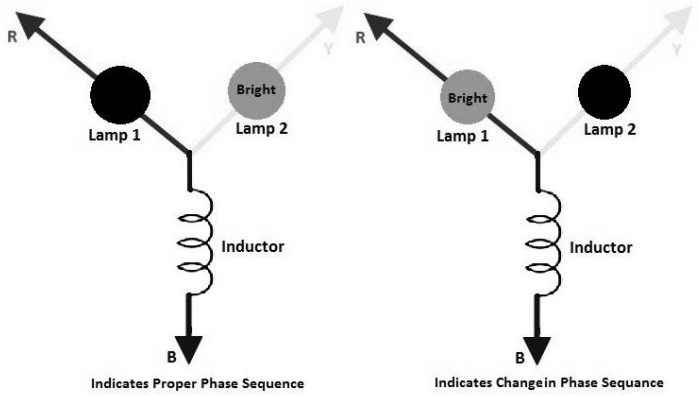
Rotating Type

It Consists of three star connected coils mounted 120^0 apart in space with three ends brought out and marked R-Y-B as shown in figure. An aluminum disc is mounted on the top of coils. The coils produce rotating magnetic field, when three phase windings are energized by three phase supply. Which sweeps the stationary aluminum disc and produces eddy emf induced in the disc which circulates an eddy current in aluminum disc. Hence a torque is produced and disc revolves, the direction of rotation depends upon the phase sequence of the supply. If the direction of the rotations is same as that indicated by arrow head, the phase sequence of the supply is same as the marked on the terminals. However if the disc revolves in opposite direction indicated to arrow head, the sequence of the supply is opposite to that marked on the terminals.

4 marks for working of any one type of phase sequence indicator with sketch

OR

b) Static type.



Connect two lamps, lamp1 to R-phase, lamp2 to Y-phase and inductor to B-phase as shown in the above figure. Resistors are connected in series with the lamps for protecting the lamps from over currents and breakdown voltages. If the sequence of supply is RYB, then the lamp 2 will glow brighter than lamp 1; if the sequence of the supply is reversed or altered, then the lamp 1 will glow brighter than the lamp

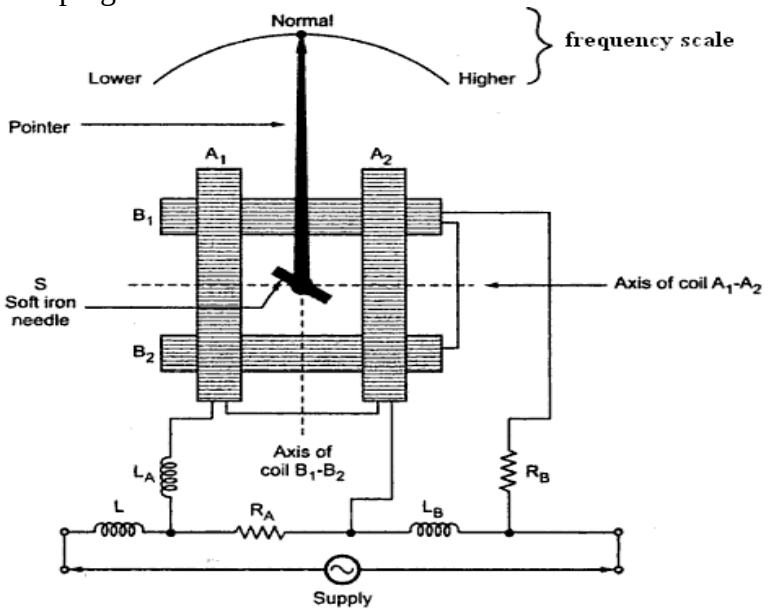
4 c) State / Describe the construction and working of weston type frequency meter with labeled diagram.

Ans:

Construction of Weston type frequency meter:

As shown in bellow diagram there are two coils A_1-A_2 & B_1-B_2 divided into two sections & perpendicular to each other. 1 mark

In the circuit of coil A(A_1-A_2) there is series combination of resistance R_A and reactance L_A in parallel with it. While in the circuit of coil B(B_1-B_2) there is series combination of resistance R_B and reactance L_B in parallel with it. A series reactance L is used to suppress higher harmonics in the incoming currents of the instrument. At the center there is spindle on which magnetic niddle (soft-iron) is pivoted. The spindle also carries an indicator and damping vane.



1 mark

Diagram of Weston type frequency meter

Working of Weston type frequency meter:

When the instrument is connected across the supply, the current flows through both coils A and B. The values of R_A, R_B, L_A, L_B are so chosen that for normal frequency the voltage drop across L_A and R_B send the equal current in coil A and B , So the fluxes act on needle is in such a way that it take center position showing normal frequency 50Hz.

2 marks

Now if the frequency is greater than 50Hz, reactance L_A and L_B increases , but R_A, R_B unaffected, this gives more voltage drop across L_A , hence more current in coil A, less current in coil B. Ultimately pointer shows higher frequency.

Now if the frequency is lesser than 50Hz, reactance L_A and L_B decreases , but R_A, R_B unaffected, this gives less voltage drop across L_A , hence less current in coil A, more current in coil B. Ultimately pointer shows lesser frequency.

4 d) State the difference between analog instruments and digital instruments.

Ans:

Difference between Analog Instruments and Digital Instruments:

Sr. No.	Analog Instrument	Digital Instrument
1	The instrument which gives output that varies continuously as quantity to be measured is known as analog instrument.	The instrument which gives output that varies in discrete steps and only has finite number of values is known as digital instrument.
2	The accuracy of analog instrument is less.	The accuracy of digital instrument is more.
3	The analog instruments required more power.	The digital instruments required less power.
4	Sensitivity of analog instrument is less.	Sensitivity of digital instrument is more.
5	The analog instruments are economical.	The digital instruments are expensive.
6	The analog instruments should be used in specific position.	The digital instruments are portable, hence can be used in any position.
7	The resolution of analog instruments is less.	The resolution of digital instruments is more.
8	These are somewhat less precise.	These are more precise.

1 mark for each of any four points = 4 marks

4 e) State the necessity and construction of earth tester with suitable sketch.

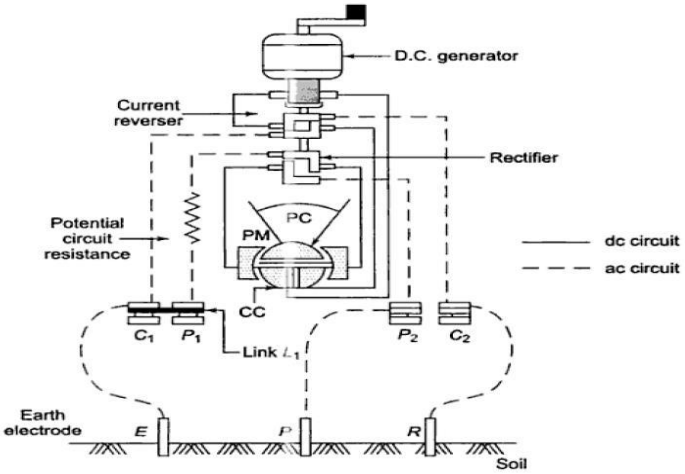
Ans:

Necessity of earth tester:

For the measurement the earth resistance. 1 mark

Construction of earth tester:

It consists of current and potential coils fixed at 90^0 to each other and constitutes the moving system. There is a pointer attached to the moving system which shows deflection on a scale. The instrument has four terminals brought outside and marked as P_1, C_1, P_2 and C_2. It also consists of hand cranked type generator, rotating current converter, rectifier. If DC send to electrodes, electrolysis may start, so it is provided with current reversal as shown in below figure. 1 mark



2 marks

5 Attempt any TWO of the following: 12

5 a) Three identical coils each of (4+j5) Ω are connected in ~~S far~~ star across 415V , 3-phase 50 Hz supply. Find,

(i) V_{ph}
(ii) I_{ph}
(iii) Wattmeter reading W_1 , W_2.

Ans:

Given: V_L= 415V , Z= 4 +j5 and f = 50 Hz

As $V_L = \sqrt{3}\, V_{ph}$

$V_{ph} = \frac{415}{\sqrt{3}} = \mathbf{239.6\ V}$ — 1 mark

Now, Z_{ph}= 4 +j5

$Z_{ph} = \sqrt{(4)^2 + (5)^2} = \sqrt{41} = \mathbf{6.40\ \Omega}$ — 1 mark

$I_{ph} = \frac{Vph}{Zph} = \frac{239.6}{6.40} = \mathbf{37.437\ A}$ — 1 mark

The angle between applied voltage and resultant current is; — 1 mark

$$\phi = \tan^{-1}\left(\frac{X_L}{R}\right) = \tan^{-1}\left(\frac{5}{4}\right) = \mathbf{51.34}^{\circ}$$

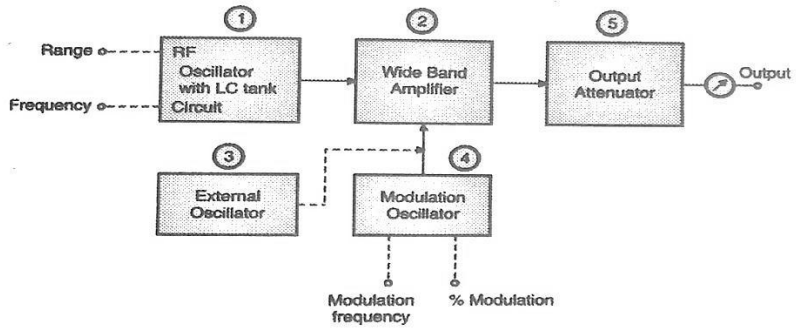
Wattmeter reading of $W_1 = V_L I_L \cos(30 - \phi)$
$= 415 \times 37.437 \times \cos(30 - 51.34)^{\circ}$
$= \mathbf{14471.14\ W}$ — 1 mark

Wattmeter reading of $W_2 = V_L I_L \cos(30 + \phi)$
$= 415 \times 37.437 \times \cos(30 + 51.34)^{0}$
$= \mathbf{2339.31\ W}$ — 1 mark

5 b) Describe with sketches various blocks and working of signal generator.

Ans:-

Block diagram of signal generator:



3 marks for Diagram

OR Any other Equivalent block diagram

Working:

i) RF oscillator: The RF oscillator having LC tank circuit produces carrier frequency. The sine wave voltages are with an appreciable range of frequency and amplitudes. The frequency of oscillation is selected for the range of frequency control and the vernier dial selling on the front panel. The modulation is indicated by a meter.

ii) Wide Band amplifier: The output signal can be AM (Amplitude Modulated) or FM (Frequency Modulated). Modulation can be done by sine wave, square wave or triangular wave or by pulse. AM is provided by external source or by internal sine wave generator. Modulation is done in output amplifier circuit which delivers its output to an attenuator.

iii) Output attenuator: The attenuator facilitates selection of proper range of attenuation and the output level is controlled. The output voltage is observed on output meter.

3 marks for Description

5 c) State the necessity of synchroscope and with neat sketch explain its working.

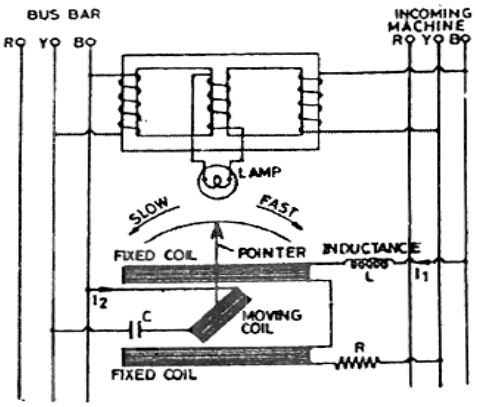
Ans:

Necessity of synchroscope:

Synchroscope is used for synchronization process. In a power system three phase alternators , transformers are connected in parallel with system. When three phase alternators are connecte to a infinite bus, the correct instant of synchronising is important to connect that incomming alternator safely to existing system. Otherwise there is local short circuit and damage to the system. So to detect the correct instant of synchronizing, synchroscope is required.

2 marks

Weston type synchroscope:



2 marks for Diagram

Working: It consists of three limbed transformer. The winding on one of the outer limbs is excited from bus- bars and that on other limb by incoming machine. The two fluxes produced by outer limbs are forced through the central limb. The resultant flux through central limb is equal to the phasor sum of these fluxes.

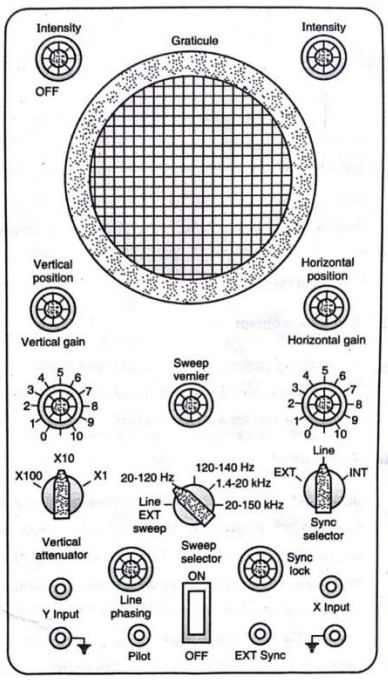
When bus-bar and incoming machine voltages are in phase, the emf induced in central limb winding is maximum hence lamp glows with maximum brightness. When bus-bar and incoming machine voltages are 180° out of phase, the emf induced in central limb is almost zero and lamp does not glow. When frequency of incoming machine is different than that of bus-bar, the lamp will flicker. The correct instant of synchronizing is when the lamp is flickering at a very much slow rate and it is at its maximum brightness.

2 marks for Working

6 Attempt any TWO of the following: 12

6 a) Draw a neat labeled diagram showing the controls available on front panel of CRO.

Ans:



Or Any Equivalent Diagram

6 marks for labeled diagram,

4 marks for partially labeled diagram,

3 marks for unlabeled diagram

6 b) State the necessity of extension of Ammeter using shunt with mathematical derivation if necessary.

Ans-

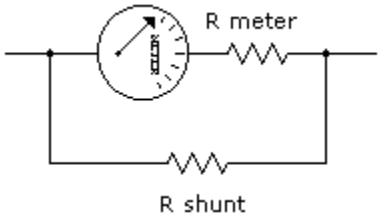
Necessity of extension of Ammeter using shunt:

i) The coil of ammeter is light in weight and delicate which carry very small current (up to 100mA).
ii) If higher values of the current are passes through this coil directly then it may damage.

2 marks for Necessity

Mathematical Derivation :-

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,
Then, $I = I_m + I_s$
Also $I_m R_m = I_s R_s$
OR
$R_s = I_m R_m / I_s$
Substituting value of I_s from above equations, we get
$R_s = I_m R_m / I - I_m$

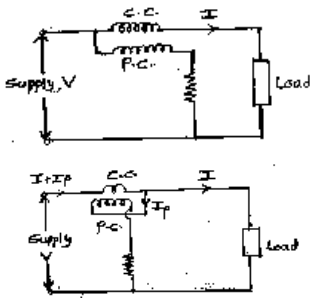


4 marks for Derivation

6 c) State the errors occurring in wattmeter and suggest the method for overcoming such type of errors. (Any six)

Ans:

Errors in Wattmeter and the method for overcoming such type of errors:

Sr. No.	Errors in Wattmeter	Compensation method
1	Error due to connection method 	To overcome this error, wattmeters are provided with additional compensating winding which is connected in series with pressure coil but positioned in such a manner that it produces a field in opposition to that produced by current in current coil.
2	Error due to pressure coil inductance	A suitable value capacitor connected in parallel with pressure coil.
3	Error due to Pressure Coil Capacitance	This error can be reduced by designing pressure coil circuit such that inductive reactance of the circuit matches exactly with the capacitance reactance of the

1 mark for each of any six points = 6 marks

		circuit i.e. $X_L=X_C$.
4	Error due to mutual inductance effect	This error can be reduced by proper design of pressure coil and current coil system so that they always remain in a zero position of mutual inductance.
5	Error due to stray magnetic fields	To avoid this error, magnetic shield is placed over CC & PC.
6	Error due to eddy currents	These are minimized by avoiding solid metal parts and using laminated core.
7	Temperature error	Using zero temperature coefficient materials for coils and components, this can be minimised.
8	Error due to vibration of moving system	It is avoided by designing the moving system such that its natural freq is greater than 2 times the freq of deflecting torque of the wattmeter.
9	Error due to friction	The weight of moving system be reduced to minimum possible.

22325

21819

3 Hours / 70 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Assume suitable data, if necessary.

(5) Use of Non-programmable Electronic Pocket Calculator is permissible.

(6) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

Marks

1. Attempt any FIVE of the following: **10**

a) Define the term 'calibration' and state its need for measuring instruments.

b) What is the difference between conventional ammeter and clip-on ammeter?

c) Calculate the resistance of shunt required to make a milliammeter which gives maximum deflection for a current of 15 mA and which has a resistance of 5 Ω, read upto 10 Amp.

d) State the difference between unity P.F wattmeter and low P.F wattmeter.

e) A single phase wattmeter rated for 500 V; 5 A is having full scale deflection of 1000 watt. What is multiplying factor of the wattmeter?

f) State the various errors in single phase electronic energy meter.

g) State any two advantages of electronic energy meter?

Marks

2. Attempt any THREE of the following: **12**

a) State the types of errors in measuring instruments and reasons of occurrence of errors.

b) Define the following terms.

(i) Precision

(ii) Drift

(iii) Resolution

(iv) Back lash

c) Distinguish between:

(i) Absolute and secondary instruments

(ii) Analog and digital instruments.

d) Which meter has a greater sensitivity and why? Meter A having a range of 0-10 V and a multiplier resistance of 18 kΩ and meter B with a range of 0-300 V and multiplier resistance of 298 kΩ? Both meter movements have a resistance of 2 kΩ.

3. Attempt any THREE of the following: **12**

a) Describe with circuit diagram, the working of full wave rectifier type A.C Voltmeter.

b) A 3-phase, 500 volt motor load has a power factor of 0.4. Two wattmeter connected to measure the input. They show the input to be 30 KW. Find the reading of each wattmeter?

c) List the various errors occurred in dynamometer type wattmeter and describe the way of compensating any one type of error.

d) Describe with circuit diagram, the calibration of single phase electronic energy meter using direct loading?

Marks

4. Attempt any THREE of the following: **12**

a) Describe with block diagram working of single phase electronic energy meter.

b) Describe with block diagram; working of signal generator and state atleast two applications of signal generator.

c) What is Trivector meter? Describe the constructional details of Trivector meter?

d) Describe how the following measurements can be made with the use of CRO:

(i) Voltage measurement

(ii) Time period measurement

e) Describe with block diagram, the working of function generator.

5. Attempt any TWO of the following: **12**

a) Explain with sketch, the construction and working principle of repulsion type moving iron instrument? Compare repulsion type MI instrument with attraction type MI instrument?

b) Explain with suitable diagram, the constructional detail and working of Dynometer type wattmeter.

c) Draw a block diagram of CRO and state the function of each block.

6. Attempt any TWO of the following: **12**

a) Explain with block diagram the construction and working principle of three phases electronic energy meter?

b) What is the necessity of synchroscope in power system? Explain with neat sketch the working of synchroscope.

c) Explain with neat sketch:

(i) Earth resistance measurement using earth tester

(ii) High resistance measurement using megger.

MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION
(Autonomous)
(ISO/IEC-27001-2013 Certified)

Summer – 2019 Examinations

Model Answers

Subject & Code: Electrical & Electronic Measurements (22325)

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.

Summer – 2019 Examinations

Model Answers

Subject & Code: Electrical & Electronic Measurements (22325)

1 Attempt any FIVE of the following: 10

1 a) Define the term 'calibration' and state its need for measuring instruments.

Ans:

Calibration: Calibration means comparing measuring instrument with Standard instrument to find out the error in the instrument under test.

Need of Calibration for Measuring Instruments:

- To ensure that the readings of an instrument are consistent in comparison with the standard instruments.
- For determining the accuracy of the instrument.
- For evaluating / adjusting the precision and accuracy of instruments.
- To eliminate or reduce error in the instrument.
- To verify whether the data obtained is reliable or correct.
- If instrument is kept idle for a long time, the instrument's conditions will change, thus calibration is needed in such cases.
- Every instrument will need to be calibrated periodically to make sure of its proper function and safety.

1 Mark for Definition and 1 Mark for any one need

1 b) What is the difference between conventional ammeter and clip-on ammeter?

Ans:

Difference Between Conventional Ammeter and Clip-on Ammeter:

Sr. No.	Conventional Ammeter	Clip-On Ammeter
1	Conventional ammeter measures the current flowing through it at the time of measurement.	Clip-on ammeter measures the current flowing through cable, bus bar, wire etc without connected with them.
2	Conventional ammeter is electrically connected with circuit.	Clip-on ammeter is magnetically coupleded with circuit.
3	Particular conventional ammeters measures AC as well as DC current.	Clip-on ammeters are generally used for measurement of AC current.
4	Measures only value of current.	Measures value of current and also has facility to measure voltage.
6	Here circuit should be made off first and then ammeter is connected in circuit for current measurement.(Circuit is disturbed)	Circuit is not disturbed while measurement of current.
7	Locking of current reading at the time of measurement is not available.	Locking of current reading at the time of measurement is available

1 Mark for each of any two points = 2 Marks

OR Equivalent Answer

1 c) Calculate the resistance of shunt required to make a milliammeter which gives

maximum deflection for a current of 15 mA and which has a resistance of 5 Ω, read upto 10 Amp.

Ans:

Given: Full scale deflection current I_G = 15 mA .

Resistance of moving coil instrument R_G = 5 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}, 1 Mark

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

$R_{sh} = I_G.R_G/(I - I_G) = 15 \times 10^{-3} \times 5/(10 - 15 \times 10^{-3})$

R_{sh} = 7.51 x 10^{-3} ohms 1 Mark

1 d) State the difference between unity P.F wattmeter and low P.F wattmeter.

Ans:

Difference Between Unity P.F. Wattmeter and Low P.F. Wattmeter:

Sr. No.	Unity P.F Wattmeter	Low P.F Wattmeter
1	UPF Wattmeter is used in short circuit test of machines / device.	LPF Wattmeter is used in open circuit test of machines / device.
2	UPF wattmeter is used for measure power in resistive circuit.	LPF wattmeter is used for measurement power in highly inductive circuits.
3	UPF Wattmeter is the instrument that measures power for higher values of power factor accurately.	LPF Wattmeter is the instrument that measures power for lower values of power factor accurately.
4	The value of deflecting torque is very low for low P.F.	The value of deflecting torque is moderate for low P.F.
5	Errors are caused due to pressure coil inductance for low P.F.	Errors due pressure coil inductance are eliminated here.

1 Mark for each of any two points = 2 Marks

OR Equivalent Answer

1 e) A single phase wattmeter rated for 500 V; 5A is having full scale deflection of 1000 watt. What is multiplying factor of the wattmeter?

Ans:

Multiplying factor = $\frac{Voltage\ Range \times Current\ Range \times PF}{FSD}$ 1 Mark

Multiplying factor = $\frac{500 \times 5 \times 1}{1000} = 2.5$ (P.F is assumed as 1) 1 Mark

1 f) State the various error in single phase electronic energy meter.

Ans:

Errors in Single Phase Electronic Energy Meter:

1)Error due to wrong sensor opeartion.

2)Error due to temperature.
3)Error due to wrong CT opeartion.
4)Error due to wrong PT opeartion.
5) Error due to wrong opeartion of scaling network.
6) Error due to wrong ADC opeartion.
7) Error due to wrong Display.

1 Mark for each of any two errors = 2 Marks

OR Equivalent Answer

1 g) State any two advantages of electronic energy meter?

Ans:

Advantages of Electronic Energy Meter:

1) Low cost.
2) High accuracy.
3) More flexibility.
4) High sensitivity
5) No frictional losses.
6) Less loading effect.
7) High frequency range.
8) Power consumption is less.
9) High resolution.
10) No requirement for external adjustment.
11) Low load, full load, power factor and creeping adjustments are not required.

1 Mark for each of any two advantages = 2 Marks

2 Attempt any THREE of the following: 12

2 a) State the types of errors in measuring instruments and reasons of occurrence of errors.

Ans:

Types of Errors With Reasons of Occurrence in Measuring Instruments:

A) Gross error: These are due to mistakes on the part of person using the instrument. 1 Mark

B)Systematic Error: 2 Marks

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

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.

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

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

C) Random error: These persist even after gross and systematic errors are removed. 1 Mark

2 b) Define the following terms.

(i) Precision
(ii) Drift
(iii) Resolution

(iv) Back lash

Ans:

(i) Precision: It is a measure of consistency or repeatability of measurements. It is also known as the degree of exactness for which an instrument is designed or intended to perform. Precision refers to the closeness of two or more measurements to each other.

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

(iii) Resolution: 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 the smallest change in the measured variable to which an instrument will responds.

(iv) Back lash: It is also known as mechanical hysteresis and it is a loss of motion in mechanical elements such as gears, linkages etc. which are used for transmission of motion.

1 Mark for each definition = 4 Marks

2 c) Distinguish between:

(i) Absolute and secondary instruments

(ii) Analog and digital instruments.

Ans:

(i) Distinction between Absolute and Secondary Instruments:

Sr. No.	Absolute Instrument	Secondary Instrument
1	It gives magnitude of quantity in terms physical constants of instrument.	It gives reading of the quantity directly on the scale at the time of measurement.
2	Calibration is not required.	Calibration with absolute instrument is required time to time as per requirements.
3	Measurement is time consuming because of tedious calculations.	Measurement is quick because of direct indication.
4	Very rarely used in practical applications.	Very widely used in practical applications.
5	Absolute instruments are used in laboratories as standardizing instruments.	Secondary instruments are used in everyday measurement work.
6	Examples: Tangent Galvanometer, Absolute electrometer, and Raleigh current balance.	Examples: Ammeter, Voltmeter, Ampere-hour meter, Wattmeter etc.

1 Mark for each of any two points = 2 Marks

(ii) Distinction between Analog and Digital Instruments:

Sr. No.	Analog Instruments	Digital Instruments
1	The instrument which gives output that varies continuously as quantity to be measured is known as analog instrument.	The instrument which gives output that varies in discrete steps and only has finite number of values is known as digital instrument.
2	The accuracy of analog instrument is less.	The accuracy of digital instrument is more.
3	The analog instruments are not affected by temperature.	The digital instruments are generally affected by temperature.
4	Sensitivity of analog instrument is more.	Sensitivity of digital instrument is less.
5	The analog instruments are economical.	The digital instruments are expensive.
6	The resolution of analog instruments is less.	The resolution of digital instruments is more.

1 Mark for each of any two points = 2 Marks

OR Equivalent Answer

2 d) Which meter has a greater sensitivity and why? Meter A having a range of 0-10 V and a multiplier resistance of 18 kΩ and meter B with a range of 0-300 V and multiplier resistance of 298 kΩ? Both meter movements have a resistance of 2 kΩ.

Ans:

For meter A: $R_S = 18\ k\Omega$ $R_m = 2\ k\Omega$ $V = 10\ V$

$R_S = (S_A\ V) - (R_m)$ ……..(Where S_A is sensitivity of meter A) 1 Mark

$18 \times 10^3 = (S_A \times 10) - (2 \times 10^3)$

$(18 + 2) \times 10^3 = S_A \times 10$

$20 \times 10^3 = S_A \times 10$

$S_A = 2000\ \Omega / V$ ……..(1) 1 Mark

For meter B: $R_S = 298\ k\Omega$ $R_m = 2k\Omega$ $V = 300\ V$

$R_S = (S_B\ V) - (R_m)$ ……..(Where S_B is sensitivity of meter B)

$298 \times 10^3 = (S_B \times 300) - (2 \times 10^3)$

$(298 + 2) \times 10^3 = S_B \times 300$

$300 \times 10^3 = S_B \times 300$

$S_B = 1000\ \Omega / V$ …….(2) 1 Mark

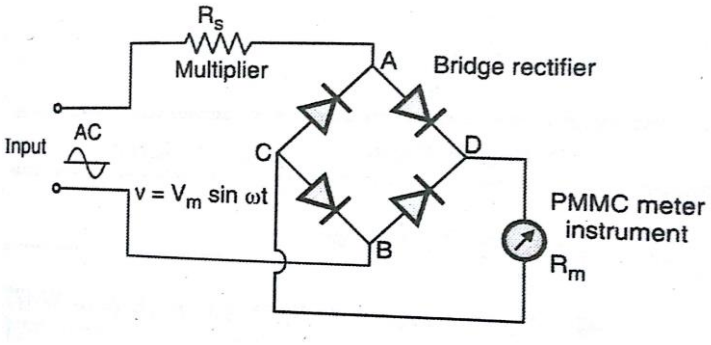
According to definition of Sensitivity and from equation (1) and (2), meter A is more sensitive than meter B. 1 Mark

3 Attempt any <u>THREE</u> of the following: 12

3 a) Describe with circuit diagram, the working of full wave rectifier type A.C Voltmeter.

Ans:

Full Wave Rectifier Type A.C Voltmeter:



2 Marks for Diagram

Circuit diagram of full wave rectifier type A. C. Voltmeter

Working of full wave rectifier type A. C. Voltmeter:

Consider the circuit diagram; here for rectification the full wave bridge circuit (ABCD) is used. Input is given across A and B in series with R_S (multiplier) ultimately d.c. is available as output voltage from points C and D to which PMMC meter is connected. Now the current passing through meter is given as, $I_M = \frac{Vdc}{Rm+Rs}$ which causes full scale deflection of the meter.

2 Marks for Working

3 b) A 3-phase, 500 volt motor load has a power factor of 0.4. Two wattmeter connected to measure the input. They show the input to be 30 KW. Find the reading of each wattmeter?

Ans:

Given: $V_L = 500V$, $\cos Ø = 0.4$ & $(W_1 + W_2) = 30kW = 30000W$

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

$30000 = \sqrt{3} \times 500 \times I_L \times 0.4$

$I_L = \frac{30000}{\sqrt{3} \times 500 \times 0.4} = 86.602$ A

1 Mark

$W_1 = V_L\, I_L \cos(30° + Ø)$

Now, $\cos Ø = 0.4$, $Ø = 66.42°$

$\therefore W_1 = 500 \times 86.602 \times \cos(30° + 66.42°)$

W_1 = (- 4842 W)

1 Mark

$W_2 = V_L\, I_L \cos(30° - Ø)$

$\therefore W_2 = 500 \times 86.602 \times \cos(30° - 66.42°)$

W_2 = (34842 W)

1 Mark

3 c) List the various errors occurred in dynamometer type wattmeter and describe the way of compensating any one type of error.

Ans:

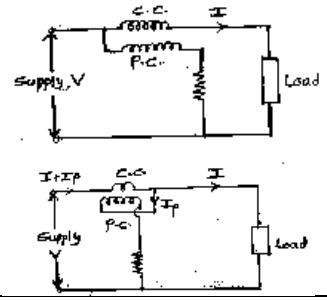
Various Errors Occurred in Dynamometer Type Wattmeter:

1) Error due to connection method.
2) Error due to pressure coil inductance.
3) Error due to pressure coil capacitance.

4) Error due to mutual inductance effect.
5) Error due to stray magnetic fields.
6) Error due to eddy currents.
7) Temperature error.
8) Error due to vibration of moving system.
9) Error due to friction.

2 Marks for any two errors

The way of Compensating the Errors:

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

2 Marks for any compensation of one error

3 d) Describe with circuit diagram, the calibration of single phase electronic energy meter using direct loading?

Ans:

Calibration of Electronic Energy Meter by Direct Loading Method:

The following figure shows the arrangement of calibration for single phase electronic energy meter. A phase shifter is connected for changing power factor of circuit.

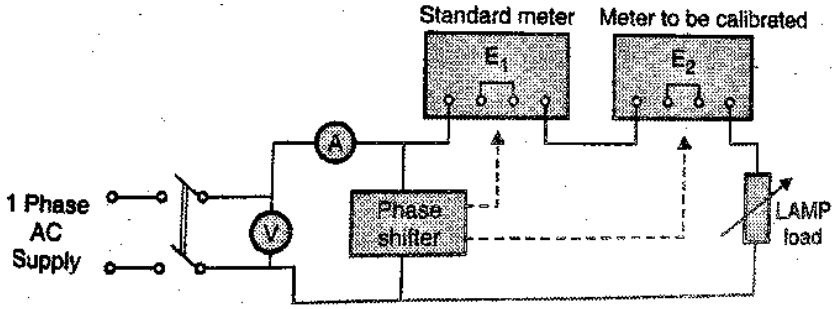
2 Marks for Description

The energy readings are taken for different values of current at different power factors.

Let D = Registration of meter under calibration in kWh &

Ds = Registration of standard meter in kWh

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



2 Marks for Diagram

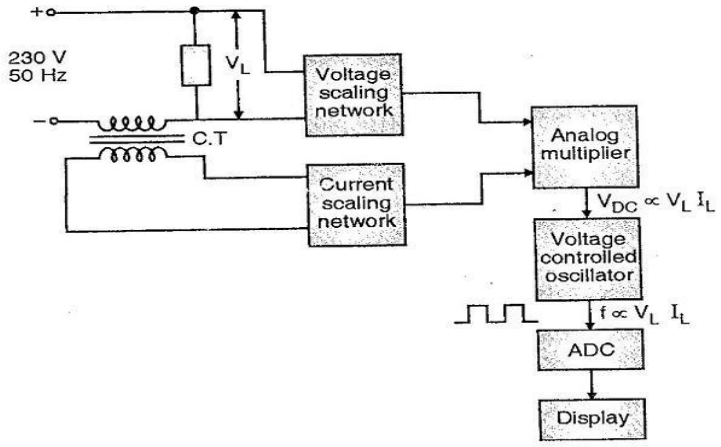
OR Equivalent Answer

4 Attempt any THREE of the following: 12

4 a) Describe with block diagram working of single phase electronic energy meter.

Ans:

Working of Single Phase Electronic Energy Meter:



2 Marks for Diagram

OR Any other equivalent layout diagram

Working of Electronic Energy Meter:-

2 Marks for Description

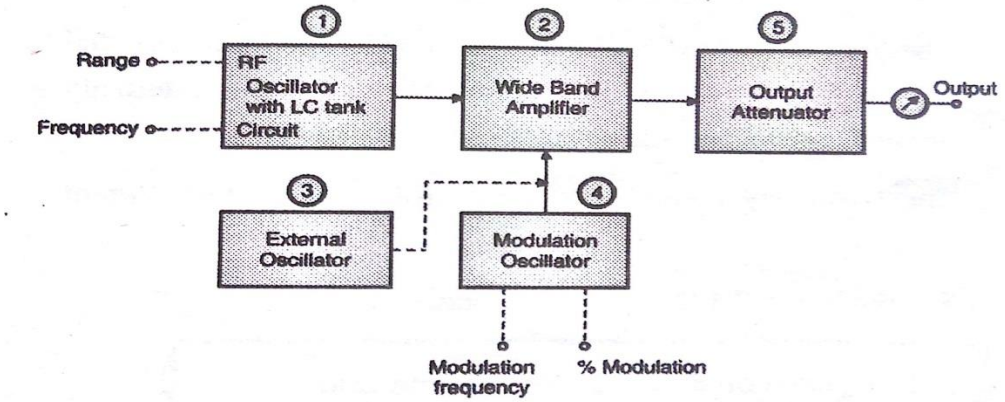
1. CT reduces current to reasonable value for current scaling network.
2. Voltage & current scaling networks reduce proportionally the voltage & current to values suitable for the analog multiplier.
3. Analog multiplier gives a dc voltage proportional to the product of the voltage and

current drawn from supply that is the power drawn.
4. The voltage controlled oscillator gives a frequency proportional to its input (which is proportional to the power).
5. The ADC converts the square wave frequency analog output to display the energy in Watt-hour.

4 b) Describe with block diagram; working of signal generator and state at least two applications of signal generator.

Ans:

Block Diagram of Signal Generator:



2 Marks for Diagram

Working:

As shown in above diagram, the RF oscillator having LC tank circuit produces carrier frequency. The sine wave voltages are with an appreciable range of frequency and amplitudes.
The frequency of oscillation is selected from the frequency range control and the vernier dial setting on the front panel. The modulation is indicated by meter.
The output signal can be AM (Amplitude Modulated) or FM (Frequency Modulated).
Modulation can be done by sine wave, square wave or triangular wave or by pulse.
AM is provided by external source or by internal sine wave generator. Modulation is done in output amplifier circuit which delivers its output to an attenuator.
The attenuator facilitates selection of proper range of attenuation and the output level is controlled. The output voltage is observed on output meter.

1 Mark for working

Other Provisions-

1. Buffer amplifiers are used for isolating the oscillator circuit from the output in high frequency oscillator.
2. Regulated power supplies are used for frequency stability of all the ranges.
3. Temperature compensation is also provided.

Applications of Signal Generator:

(i) It is used for Bandwidth measurement.
(ii) It is used for Gain measurement.
(iii) It is used for Signal to noise ratio measurement.
(iv) It is used for standing wave ratio and other properties measurement.
(v) It is used for testing of transmitters
(vi) It is used for testing of radio receivers.

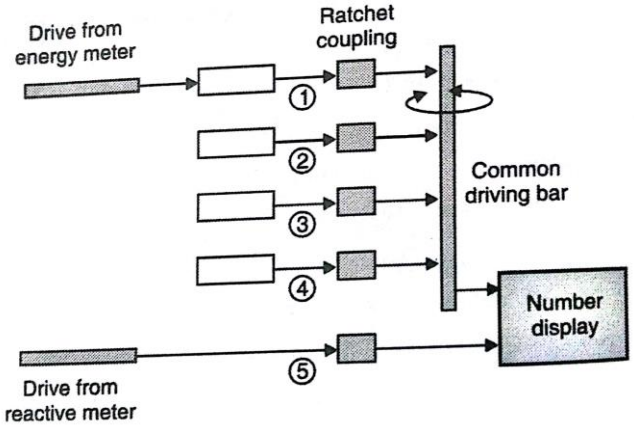
1 Mark for any two applications

4 c) What is Trivector meter? Describe the constructional details of Trivector meter?

Ans:

Trivector Meter:

Trivector meter is a measuring instrument which measures the active, reactive power and total Energy consumed. They are normally used in substations to measure the power flowing through the feeders and for billing the industrial consumers. — 1 Mark



2 Mark for Diagram

It is an electromechanical meter with gears and ratchet coupling mechanism.
It consists of five gearing systems as:
Gearing system 1 : For watt hour meter
Gearing system 2 : For watt hour meter with p.f. 0.924 and driven at reduced speed
Gearing system 3 : For watt hour meter with p.f. 0.707 and driven at reduced speed
Gearing system 4 : For watt hour meter with p.f. 0.383 and driven at reduced speed
Gearing system 5 : For reactive meter driven at normal speed. — 1 Mark
Whenever power factor of the load changes, the driving mechanism shifts to respective ratchet couplings and system drives the mechanism.
The display unit is connected to common driving bar and the respective numbers of KVAh are displayed on it.

4 d) Describe how the following measurement can be made with the use of CRO:
(i) Voltage measurement
(ii) Time period measurement

Ans:

Procedure of Voltage Measurement with use of CRO:

- Through vertical amplifier apply a voltage to be measured to Y deflection plate
- The X deflection plates are excited by the time base generator.
- A set of squares is marked on the transparent screen cover which aids measurements.
- Using these markings and the gain of vertical amplifier, the peak to peak (p-p) value (and hence r.m.s. value) of the voltage can be measured.
- After noting down the selection in volts / division from the front panel (which is selected for measurements) the peak to peak value(p-p), amplitude and r.m.s. value of sinusoidal signal can be obtained as : — 2 Marks

Peak to peak (V_{p-p}) $= \left(\frac{\text{Volts}}{\text{division}}\right) \times$ No. of divisions

Amplitude $= V_{max} = \frac{Vp-p}{2}$

RMS Value ($V_{r.m.s.}$) $= \frac{Vp-p}{2\sqrt{2}}$ for sinusoidal signals

Procedure of Time Period Measurement using CRO:

- The waveform is displayed on the screen such that one complete cycle is visible on the screen.
- If single cycle occupies full or major horizontal distance then the accuracy in measurement is much more.
- Select time / division on the front panel and note it.
- The time period (T) can be calculated as:

Time period (T) = $\left(\frac{time}{division}\right) \times$ No. of divisions occupied by one cycle.

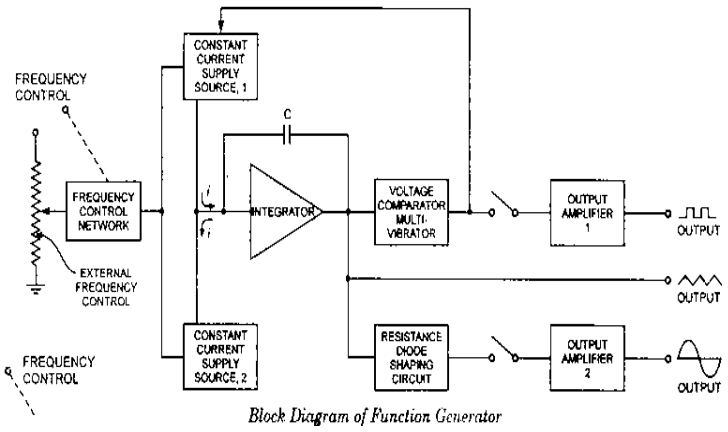
2 Marks

OR Equivalent Answer

4 e) Describe with block diagram, the working of function generator.

Ans:

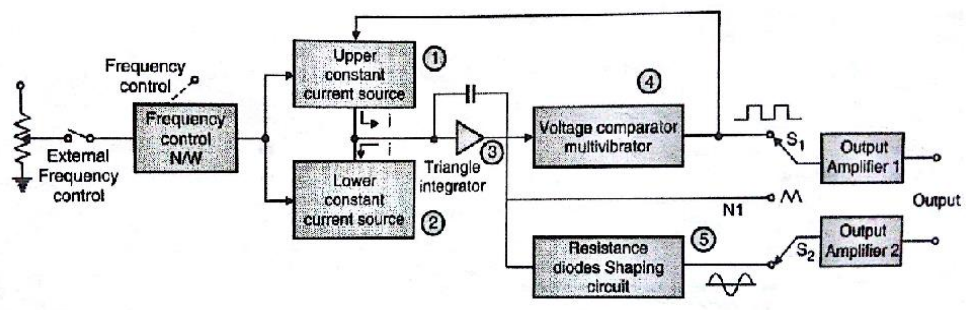
Block Diagram of Function Generator:



Block Diagram of Function Generator

2 Marks for Diagram

OR



Working of Function Generator :

- This instrument can deliver sine, triangular & square 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.

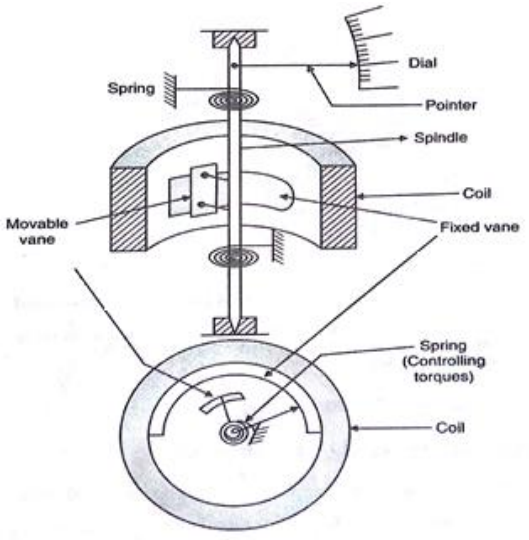
2 Marks for Working

5 Attempt any TWO of the following: 12

5 a) Explain with sketch, the construction and working principle of repulsion type moving iron instrument? Compare repulsion type MI instrument with attraction type MI instrument?

Ans:

Repulsion Type Moving Iron Instrument:



2 Marks for Diagram

Construction:

It consist of fixed cylindrical hollow coil which carries operating current. Inside the coil, there are two soft iron pieces. One of which is fixed other is movable. The fixed iron piece is attached to the coil whereas the movable iron piece is attached to the spindle. Under the action of deflecting torque, the pointer attached to the moving system moves over the scale. The controlling torque is provided by spring control and damping torque is provided by air friction.

1 Mark for construction

Working Principle:

When the coil carries current (AC or DC), the two iron pieces are magnetized with

same polarity and a repulsive force act on them. Due to this force, the moving iron piece gets deflected and becomes steady when the deflecting force becomes equal to the controlling force.

1 Mark for Principle

Comparison of Repulsion type Instrument with Attraction type Instrument:

Sr. No	Parameter	Attraction type MI instrument	Repulsion type MI instrument
1	Working Principle	The coil when carries current, it produces magnetic field, strong inside the coil and weaker outside the coil. The soft iron piece placed near to the coil gets attracted to the stronger magnetic field inside the coil. This attractive force acts as deflecting force.	The coil when carries current, it produces magnetic field inside the coil. Due to this magnetic field, the two iron pieces are magnetized with same polarity. Therefore, a repulsive force act on the iron pieces and moving iron piece gets deflected
2	Deflecting torque	Iron piece gets attracted towards strong magnetic field inside the coil and deflection torque is produced.	Repulsive force between two similarly magnetized iron pieces produces the deflection torque.
3	Controlling torque	By the springs but gravity control may also be used for vertically mounted panel type instruments.	By spring control method.
4	Iron pieces	One iron piece is used	Two iron pieces are used.

1 Mark for each of any two points = 2 Marks

5 b) Explain with suitable diagram, the constructional detail and working of ~~Dynometer~~ Dynamometer type wattmeter.

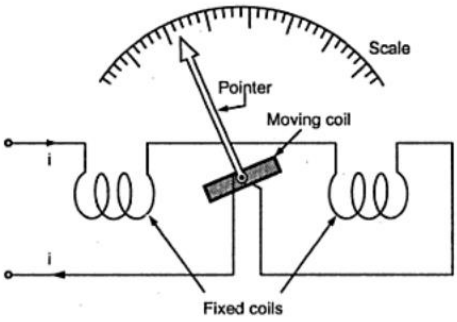
Ans:

Dynamometer Type Wattmeter

Construction:

It essentially consists of the two fixed coils and one moving coil. The fixed coils are placed close together and parallel to each other. Moving coil is pivoted in between the two fixed coils.The fixed and moving coils are excited / connected as shown in figure. The moving coil is attached to the moving system so that under the action of deflecting torque, the pointer moves over the scale. Controlling torque is provided by springs and damping torque is provided by air friction damping.

2 Marks for construction



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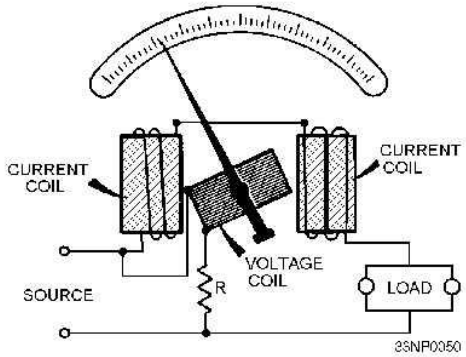


2 Marks for Diagram

Working:

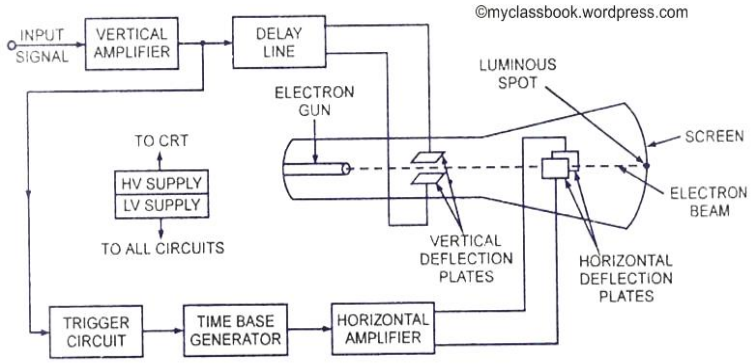
When the instrument is connected in the circuit, operating current flow through the coils. The interaction between the magnetic fields produced by the coils produces mechanical force on the movig coil. The result is that moving coil moves the pointer over the scale to give reading. Since fixed coil current is proportional to the load current and the moving coil current is proportional to the voltage, the deflecting torque is proportional to the product of voltage and current i.e power. When direction of current reverses, then it reverses the direction of current of fixed as well as moving coil so that the direction of deflecting torque remains unchanged. Hence these instruments can be used for measurement of A.C. & D.C. power.

2 Marks for working

5 c) Draw a block diagram of CRO and state the function of each block.

Ans:

Block Diagram of CRO With Function of Each Block:



3 Marks for Diagram

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

3 Marks

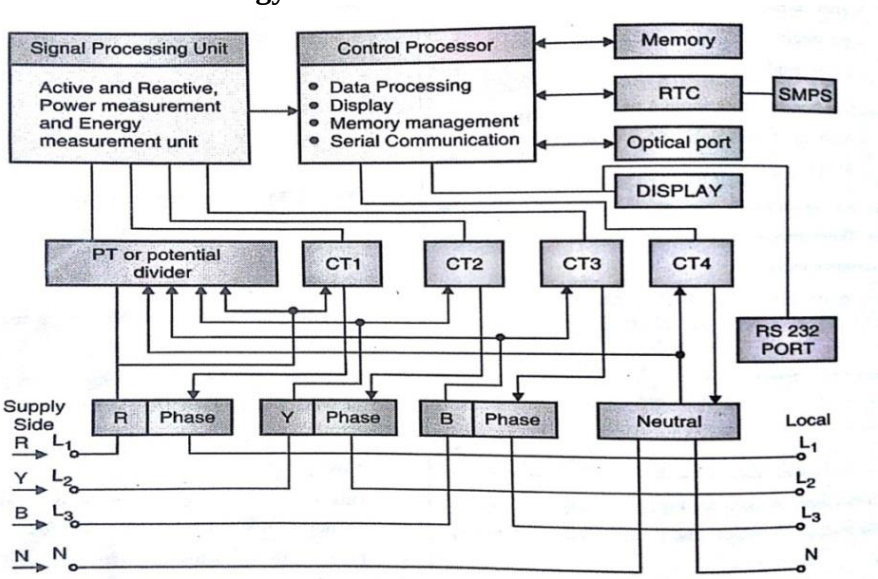
waveform of the input signal.

6 Attempt any TWO of the following: 12

6 a) Explain with block diagram the construction and working principle of three phases electronic energy meter?

Ans:

Three Phases Electronic Energy Meter:



2 Marks for Diagram

Construction:

As shown in above diagram, the three phase supply terminals with neutral point (R, Y, B & N) are connected from supply side. CT_1, CT_2, CT_3, are connected in R, Y, B phase respectively. They steps down the current to a suitable value and give it to a signal processing unit. PT or potential divider unit is used to step down the line voltage to a suitable value and give it to a signal processing unit. CT_4 is connected in neutral to check balance load condition.

2 Marks for Construction

Working:

- The signal processing unit computes the active, reactive power & energy in kWh.
- The control processor does the necessary data processing work and memory management to monitor and evaluate different parameters.
- Real time clock (RTC) is provided for synchronization of all data processing works. The display unit is interfaced with control processor.
- Different electric parameters can be displayed on LCD display and SMPS is provided to give constant DC supply.
- The Data in energy meter can be transferred to an external device like AMR through RS232 port.

2 Marks for Working

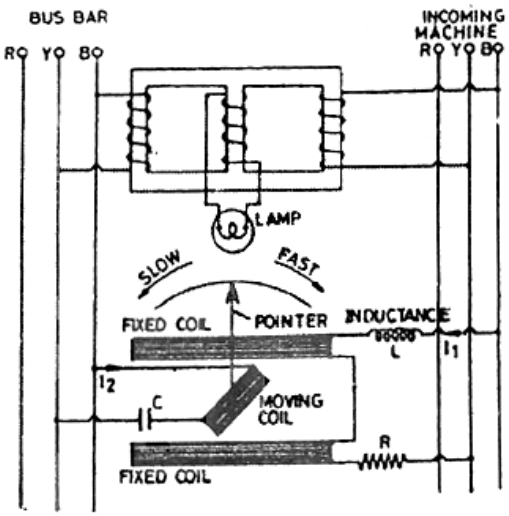
6 b) What is the necessity of synchroscope in power system? Explain with neat sketch the working of synchroscope.

Ans:

Necessity of Synchroscope:

In a power system, three phase alternators , transformers are connected in parallel with each other and with bus bars. When three phase alternators are to be connected to an infinite bus, the correct instant of synchronising is important to connect that incomming alternator safely to existing system. So to detect the correct instant of synchronizing, Synchroscope is used. — 2 Mark for necessity

Weston type Synchroscope:



2 Mark for Diagram

Working:

It consists of three limbed transformer. The winding on one of the outer limbs is excited from bus- bars and that on other limb by incoming machine. The two fluxes produced by outer limbs are forced through the central limb. The resultant flux through central limb is equal to the phasor sum of these fluxes.

When bus-bar and incoming machine voltages are in phase, the emf induced in central limb winding is maximum hence lamp glows with maximum brightness. When bus-bar and incoming machine voltages are 180^0 out of phase, the emf induced in central limb is almost zero and lamp does not glow. When frequency of incoming machine is different than that of bus-bar, the lamp will flicker. The correct instant of synchronizing is when the lamp is flickering at a very much slow rate and it is at its maximum brightness. — 2 Mark for Working

6 c) Explain with neat sketch:
- (i) Earth resistance measurement using earth tester
- (ii) High resistance measurement using megger.

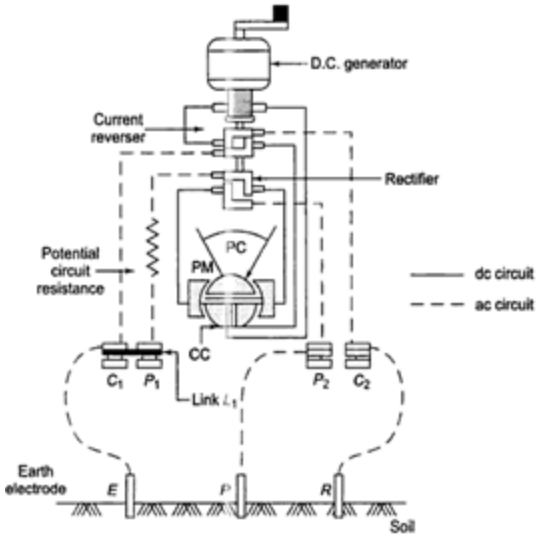
Ans:

Earth Resistance Measurement Using Earth Tester:

It is connected to earth electrode whose resistance is to be measured, and the other spike P and R, as shown in the figure.

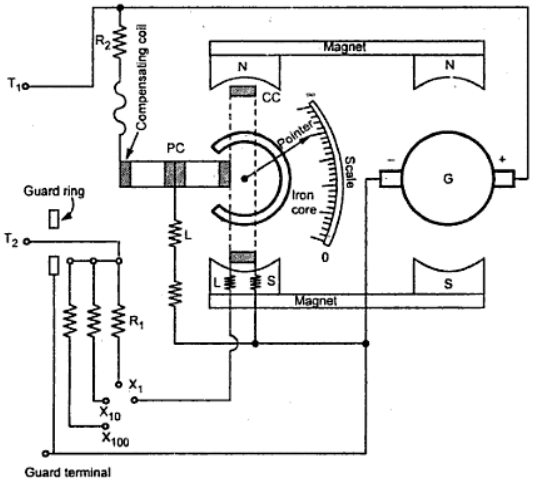
When handle is rotated the D.C. flows from the generator through the current coil of the movement to the current reverser, and alternating current from the reverser through the soil between the electrode E and R . This voltage drop between electrode P and E is rectified by the rectifier and fed to the 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 earth — 3 Marks for Earth tester

resistance in ohm of the earth electrode under test.



High Resistance Measurement Using Megger:

Working of Megger:



3 Marks for Megger

Two coils i.e. 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.