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.

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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:

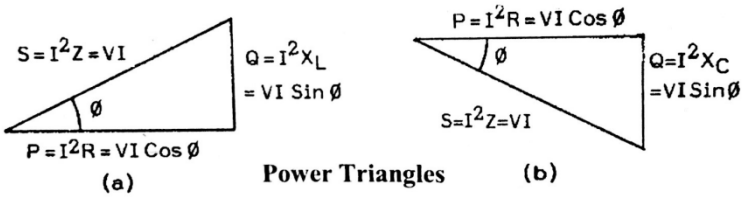
PMMC: Permanent Magnet Moving Coil. — 1 mark

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.

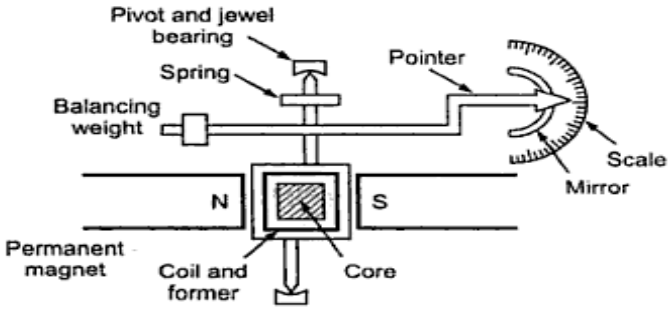
(viii) Back lash: It is a loss of motion in mechanical elements such as gears, linkages etc which are used for transmission of motion.

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)

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

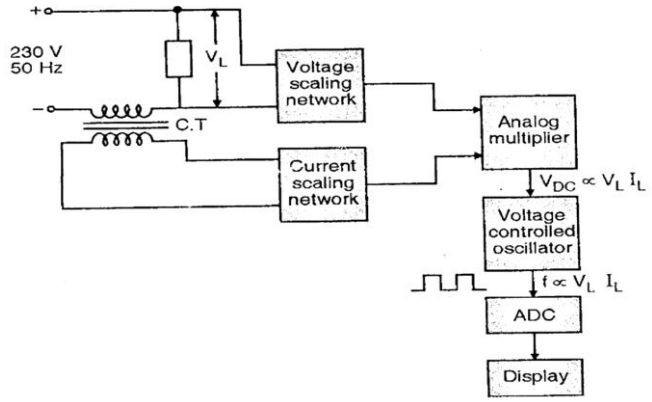
1 mark

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.

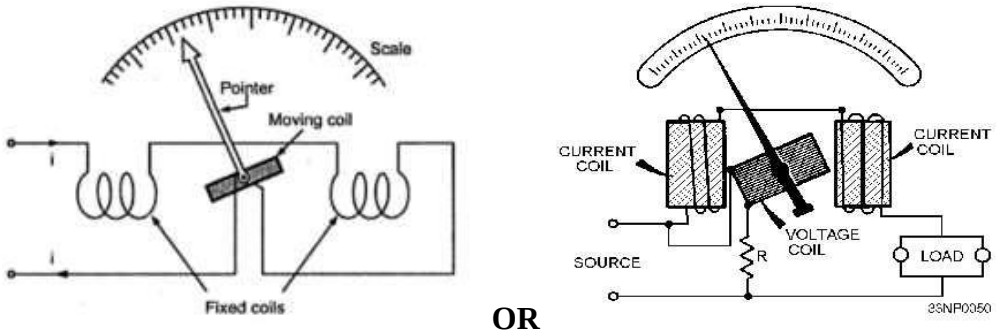
(2 marks for any two merits)

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

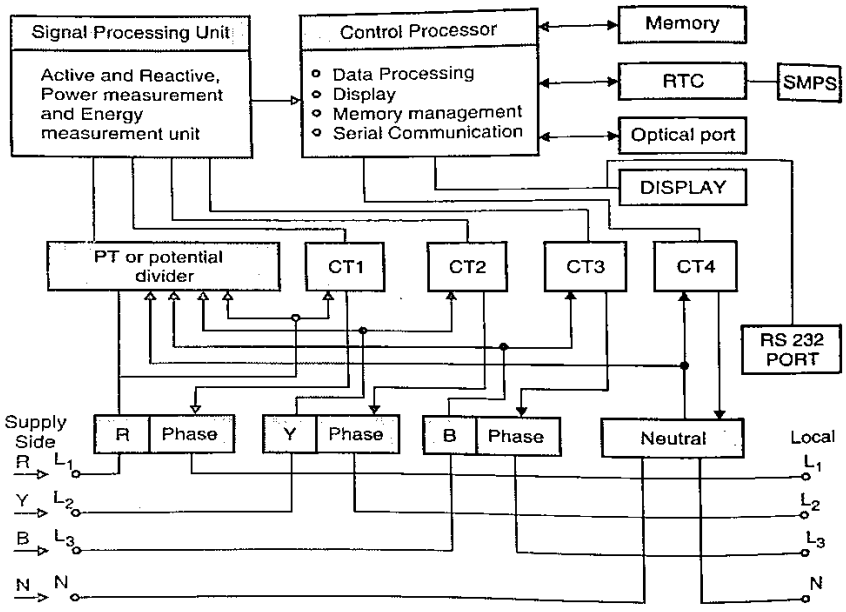
Working of Dynamometer type wattmeter:

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

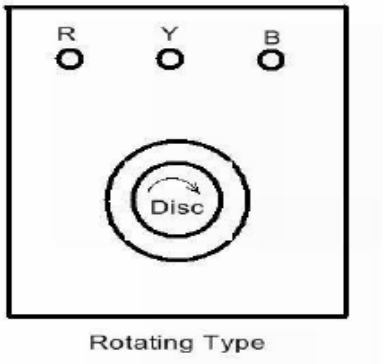
4 b) State and explain working of phase sequence indicator with suitable sketch.

Ans:

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

(a) Rotating type (b) Static type.

a) Rotating type



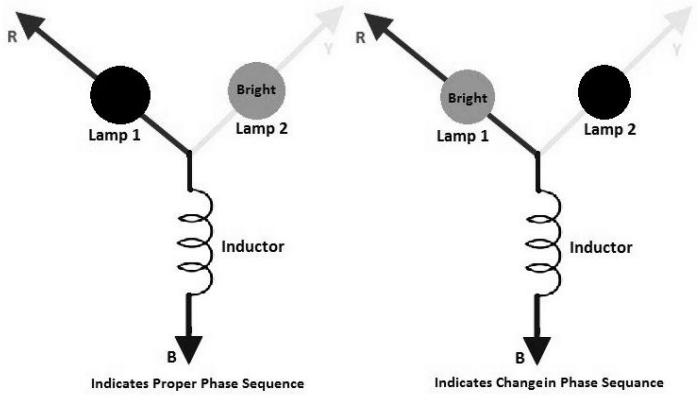
Rotating Type

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

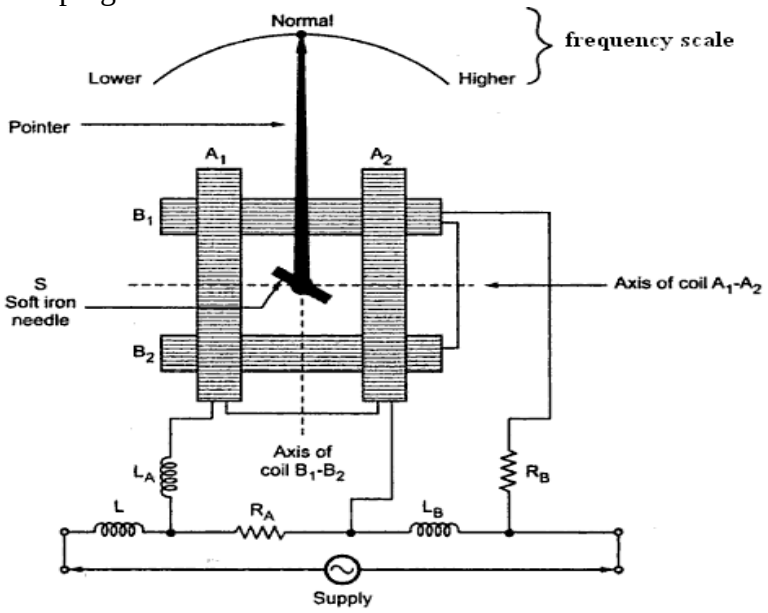
4 c) State / Describe the construction and working of weston type frequency meter with labeled diagram.

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.

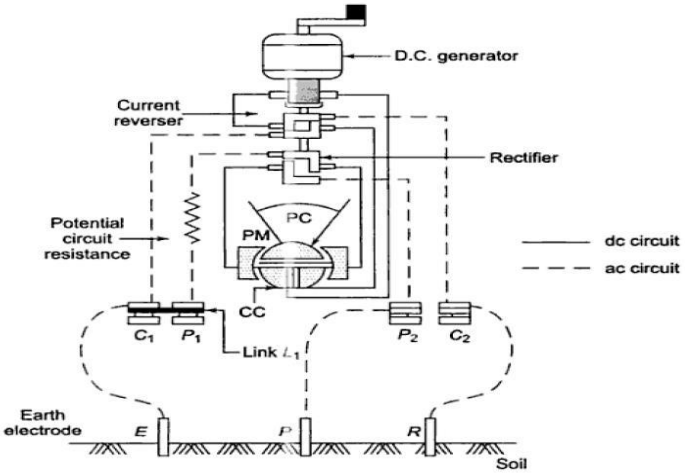
Ans:

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

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

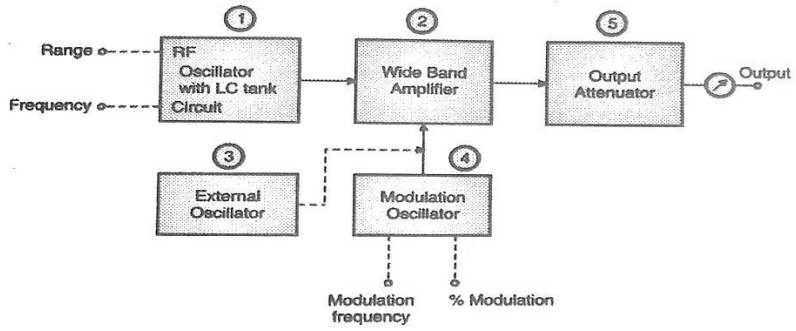
Wattmeter reading of $W_1 = V_L I_L \cos(30 - \phi)$
$= 415 \times 37.437 \times \cos(30 - 51.34)^\circ$
$= \mathbf{14471.14\ W}$ — 1 mark

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.

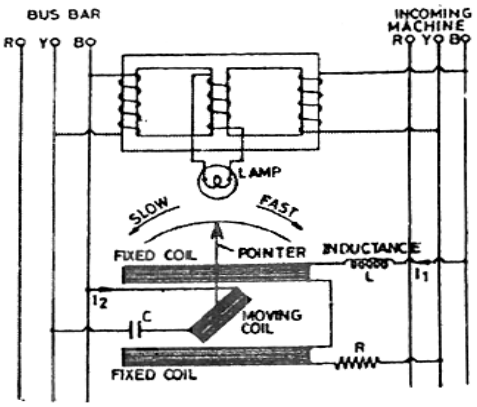
Ans:

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.

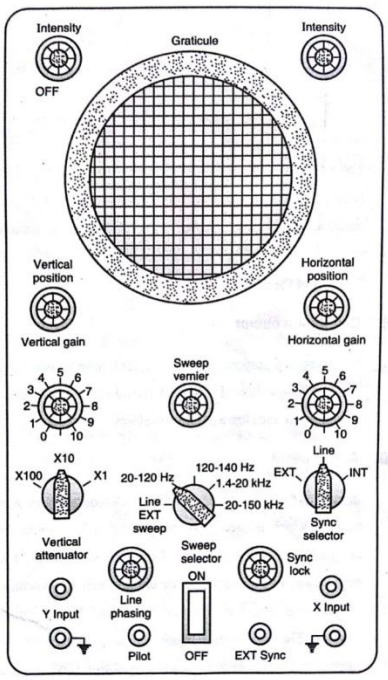
When bus-bar and incoming machine voltages are in phase, the emf induced in central limb winding is maximum hence lamp glows with maximum brightness. When bus-bar and incoming machine voltages are 180° out of phase, the emf induced in central limb is almost zero and lamp does not glow. When frequency 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-

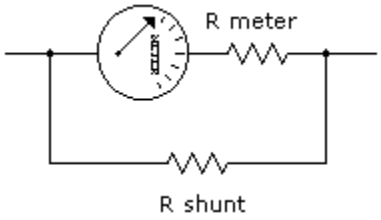
Necessity of extension of Ammeter using shunt:

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
$R_s = I_m R_m / I - I_m$

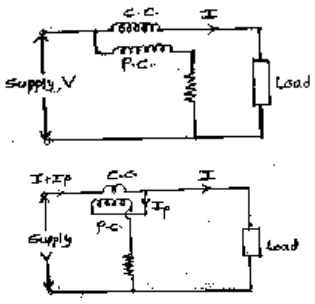


4 marks for Derivation

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.