WINTER – 2022 EXAMINATION

Model Answer

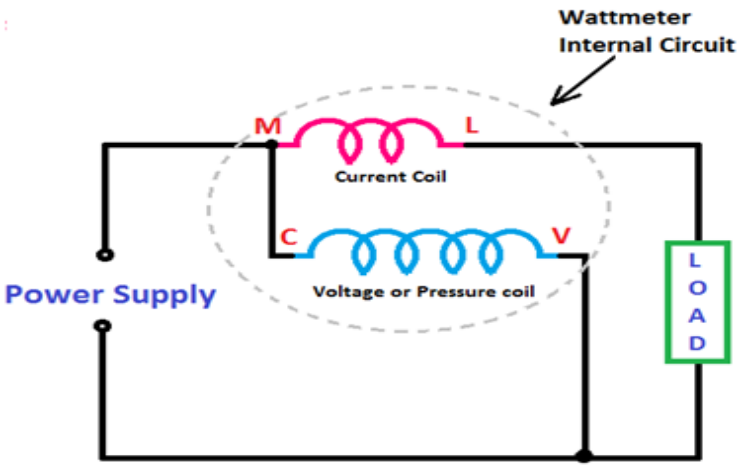
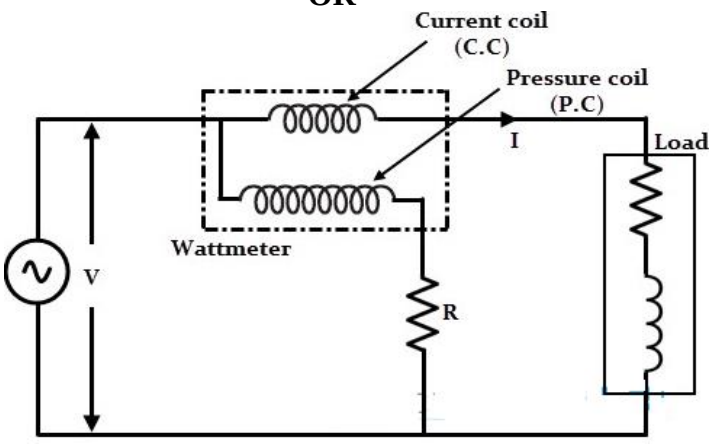
Subject Name: Electrical and Electronic Measurements. **22325: EEM**

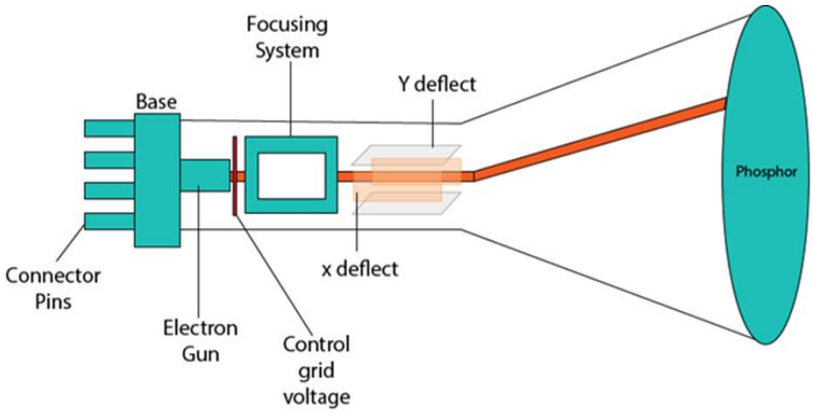
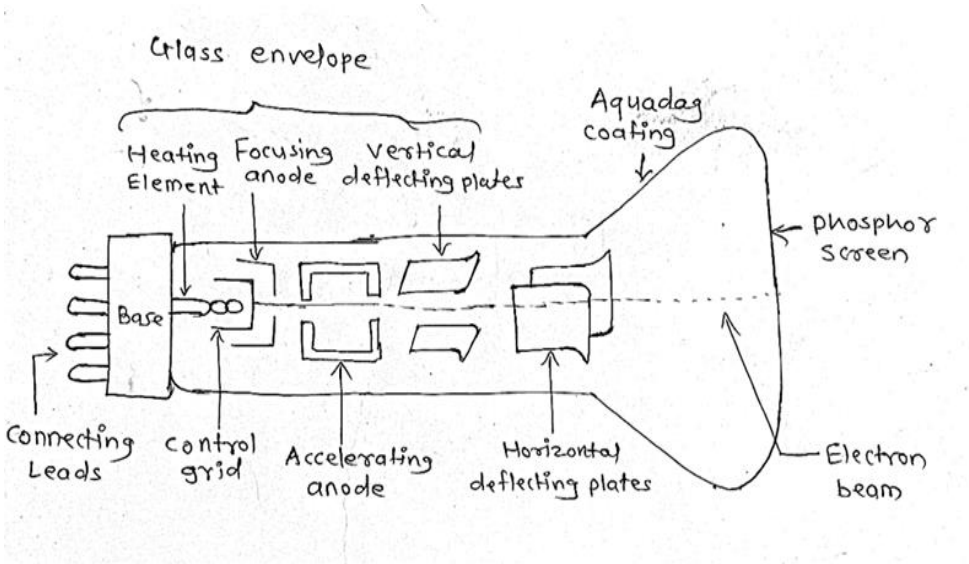
Important Instructions to examiners:

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.
8) As per the policy decision of Maharashtra State Government, teaching in English/Marathi and Bilingual (English + Marathi) medium is introduced at first year of AICTE diploma Programme from academic year 2021-2022. Hence if the students in first year (first and second semesters) write answers in Marathi or bilingual language (English +Marathi), the Examiner shall consider the same and assess the answer based on matching of concepts with model answer.

<table>
<tr><th>Q. No.</th><th>Sub Q. N.</th><th>Answer</th><th>Marking Scheme</th></tr>
<tr><td>1.</td><td></td><td>Attempt any FIVE of the following:</td><td>10 Marks</td></tr>
<tr><td></td><td>a)</td><td>State significance of measurement.
Ans:
Significance of Measurement:
1. The complete area of automation / automatic control is based on measurement.
2. The new discoveries / innovations require sophisticated measurement techniques.
3. The measurement is required to monitor a process / operation.
4. It is required to measure all physical / electrical / mechanical quantities.
5. The measurements are required in a research and development (R&D) department.
6. The measurement is widely required in various industries for quality production.
7. Measurement is widely required in various educational institutes for training purpose.
8. The measurement is required for trading and dealing purposes.
9. The measurement is required to set particular standards and tolerances.
10. The measurement conforms validity of hypothesis and adds its understanding.
11. Proper operation / economical design & maintenance is possible with measurement only.
12. For obtaining good results in engineering measurement is required.
13. All electrical quantities also need measurement. for e.g., voltage, current, wattage etc.
14. For controlling & feedback purpose the measurement is essential.</td><td>½ Mark for each of any four points = 2 Marks</td></tr>
<tr><td></td><td>b)</td><td>List difference between D.C. and A.C. voltmeters.
Ans:
Difference Between D.C. and A.C. Voltmeters:
<table>
<tr><th>Sr. No.</th><th>D. C. Voltmeters</th><th>A. C. Voltmeters</th></tr>
<tr><td>1</td><td>DC voltmeter measures DC voltage.</td><td>AC Voltmeter measures AC voltage.</td></tr>
<tr><td>2</td><td>The DC voltmeter measures the peak value of DC voltage.</td><td>AC voltmeter measures the RMS value of the AC voltage.</td></tr>
<tr><td>3</td><td>DC voltmeters are highly sensitive</td><td>The AC voltmeters are somewhat low sensitive relatively.</td></tr>
</table></td><td>1 Mark for each of any two differences = 2 Marks</td></tr>
</table>

		4	DC voltmeter does do not use rectifier before multistage amplifier.	Rectifier is required in AC voltmeter as per the application.
		5	DC voltmeters are highly efficient most accurate.	AC voltmeters are less efficient and accurate than DC voltmeter.
		6	DC voltmeters are much costly.	AC voltmeters are comparatively less costly.
		OR Equivalent Answer/Points		
	c)	State the advantages of P.M.M.C. instrument. **Ans:** **Advantages of PMMC type instrument:** 1. Scale is uniform. 2. Power consumption is very low. 3. Can be used as ammeter or voltmeter of different ranges with the help of shunt and multiplier. 4. More sensitive as compared with MI / dynamometer type instruments. 5. The torque to weight ratio is high which gives a high accuracy. 6. Most accurate instrument for measurement of DC quantities. 7. Effective eddy current damping. 8. Errors due to stary magnetic fields are small, due to strong operating magnetic field.		½ Mark for each of any four advantages = 2 Marks
	d)	State any two benefits of electronic energy meter. **Ans:** **Benefits of Electronic Energy Meter:** 1. The electronic energy meter displays the reading in the numeric values ultimately reduces the errors and the users can easily read / understand the readings. 2. The electronic energy meter eliminating manual meter reading and ultimately removes the associated errors. 3. The electronic energy meter not only measures the electrical energy but also monitors the electric system. 4. The electronic energy meter makes possible to use power resources more efficiently. 5. The electronic energy meter provides real-time data useful for balancing electric loads and reducing power outages (blackouts). 6. The electronic energy meter enables the consumers to adjust their habits to lower electric bills. 7. The electronic energy meters are widely available in compact or small sizes. So, they are very easy to carry. 8. The electronic energy meters offer more detailed feedback on energy utilization. 9. The electronic energy meters have high accuracy than the analog energy meters. 10. The digital output is obtained by the electronic energy meters which acts as an input for the memory devices like floppy, recorder, printer etc. is useful for further analysis, study and research work. 11. The electronic energy meters have no frictional losses and errors. 12. The electronic energy meter offers more flexibility. 13. The electronic energy meters are of highly sensitive meters. 14. The electronic energy meters can operate for high frequency range. 15. The electronic energy meter operates with high resolution. 16. The electronic energy meter does not require any external adjustments for its operation.		1 Mark for each of any two benefits = 2 Marks

		17. The electronic energy meter does not affect much by loading effect. 18. The cost of electronic energy meter is reasonable, it not costly. 19. There is less chance to get errors in electronic / digital energy meter while measuring or reading. Thus, it is sometimes called a 'Smart Meter' or 'Advanced Meter'. 20. The electronic energy meter does not contain moving parts so less maintenance is required. 21. In electronic / digital energy meter data / range hold functions are available so they become more effective. 22. The data from the electronic / digital energy meter can be recorded for future reference or future planning/ future load predictions etc. 23. The electronic / digital energy meters are highly efficient than the analog energy meters. 24. The electronic / digital energy meters improve awareness of energy consumption. By changing behavioural habits & decisions to buy more energy efficient appliances there is less pressure on the electricity grid.	
	e)	Draw a neat sketch of wattmeter connection. **Ans:** **Sketch of Wattmeter Connection:**  **OR**  **OR Equivalent Diagram**	2 Marks
	f)	List out methods used for measurement of medium resistance.	

		Ans: **Methods used for Measurement of Medium Resistance:** 1. Wheatstone bridge method. 2. Ammeter - voltmeter method. 3. Substitution method. 4. Carey-foster slide wire bridge method. 5. Digital / analog multi-meter.	½ Mark for each of any four = 2 Marks
	g)	Sketch internal structure of CRT. **Ans:** **Sketch Internal Structure of CRT:**  **Cathode Ray Tube** **OR**  **OR Equivalent Diagram**	2 Marks
2.		**Attempt any <u>THREE</u> of the following:**	**12 Marks**
	a)	List out comparisons between deflection and null type instruments. **Ans:** **Comparisons Between Deflection and Null Type Instruments:**	

Sr. No.	Deflecting Type Instruments	Null Type Instruments
1	The deflection of these instruments provides a basis for determining the quantity under measurement.	In null type instruments, zero or null indication leads to determination of the magnitude of measurend.
2	These are less accurate.	These are more accurate.
3	These are less sensitive.	These are more sensitive.
4	Easy measurement procedure i. e. Very convenient to use.	Complex measurement procedure as extra effort are required to find null point.
5	Normally used for daily measurement work.	Normally used for calibration work.
6	In deflection type instrument, the detector need to be measure the quantity but it has nothing to do with the balance / unbalance condition.	In null type instrument, the detector need not be measure the quantity but it has only to detect the presence and direction of unbalance and not the magnitude of unbalance.
7	Suitable for measurements under dynamic conditions.	Less suitable for measurements under dynamic conditions.
8	Examples are PMMC ammeters, Electrodynamometer and moving iron instruments etc.	Example is Galvanometer.

1 Mark for each of any four points = 4 Marks

OR Equivalent Answer/Points

b) State errors occurring in measurement of electrical power.

Ans:

Errors Occurring in Measurement of Electrical Power:

1. Error due to method of connection.
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 eddy currents.
6. Stray magnetic field error.
7. Error caused by vibration of the moving system.
8. Temperature error.
9. Error due to friction.
10. Gross errors.
11. Systematic errors.
    a) Instrumental errors.
    b) Environmental errors.
    c) Observational errors.
12. Random errors.

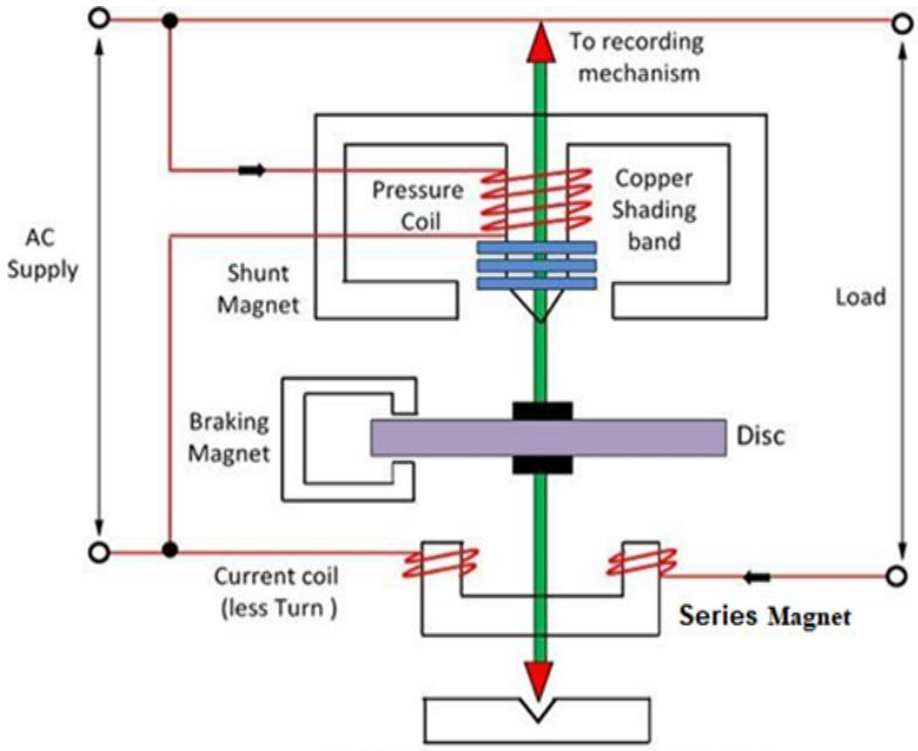
1 Mark for each of any four = 4 Marks

c) Explain with neat diagram construction and working of induction type energy meter.

Ans:

Construction and Working of Induction Type Energy Meter:

Construction:



Induction Type Energy Meter

2 Marks for Diagram

1 Mark for construction

1. **Driving system:** Shunt magnet is E shaped and series magnet is C-shaped. Pressure coil with thin conductor and large number of turns is wounded on shunt magnet and current coil is of thick conductor and few number of turns. The electromagnets are made up of silicon steel stampings. Copper shading band is used on central limb of shunt magnet.
2. **Moving system:** In this aluminium disc is suspended between shunt and series magnet. The spindle carries aluminium disc, jewel bearing is used for supports.
3. **Braking system:** One permanent magnet (Breaking magnet) is used for braking system at the edge of the aluminium disc. We can change the speed of the disc by changing location of breaking magnet.
4. **Registering mechanism:** The gears are used in the registering mechanism. This counts number of revaluations over a period of time.

1 Mark for working

Working:

An alternating current pass through the shunt magnet and series magnet they produce flux. The magnetic flux from the shunt coil is proportional to supply voltage and from series magnet it is proportional to load current. The resultant flux links with the aluminium disc and produces eddy current, the disc starts rotating. The rotation of disc is proportional to power. (N – speed of disc is proportional to VI cos ϕ).

d) A 220V, 5A, d.c. energy meter is tested at its marked ratings. The resistance of the pressure circuit is 8800 Ω and that of current coil is 0.1 Ω. Calculate the power consumed when testing the meter with direct loading arrangement.

Ans:

Given-Data:

Supply voltage = 220V, Full load current = 5A, Pressure coil resistance = 8800 Ω, Current

coil resistance = 0.1 Ω.

Power Consumed by Pressure Coil:

$$P_{(\text{Pressure coil})} = \frac{V^2}{R}$$ ½ Mark

$$P_{(\text{Pressure coil})} = \frac{220^2}{8800}$$ ½ Mark

$$P_{(\text{Pressure coil})} = \mathbf{5.5\ watts.}$$ ½ Mark

Power Consumed by Current coil:

$$P_{(\text{Current coil})} = I^2 R$$ ½ Mark

$$P_{(\text{Current coil})} = (5)^2 \times 0.1$$ ½ Mark

$$P_{(\text{Current coil})} = \mathbf{2.5\ watts}$$ ½ Mark

Total Power consumed by direct loading = 5.5 + 2.5 = 8 watts. 1 Mark

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

a) State the difference between analog and digital instrument.

Ans:

Difference Between Analog and Digital Instruments:

Particular	Analog Instruments	Digital Instruments
Definition	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.
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	Power is not required for operation of analog instruments.	Power is required for operation of digital instruments.
Affected by temperature	The analog instruments are less affected by temperature.	The digital instruments are much more affected by temperature.
Sensitivity	Sensitivity is less.	Sensitivity is more.
Cost	Presently most analog instruments are economical.	Presently some digital instruments are economical, while most are costly.
Position of instrument	The analog instruments should be used in specific position.	The digital instruments are portable, hence can be used in any position.
Precision	These are somewhat less precise.	These are more precise.
Possibility of human error	Exists.	Does not exist.
Presence of moving	Moving part involved.	No moving part.

1 Mark for each of any four points = 4 Marks

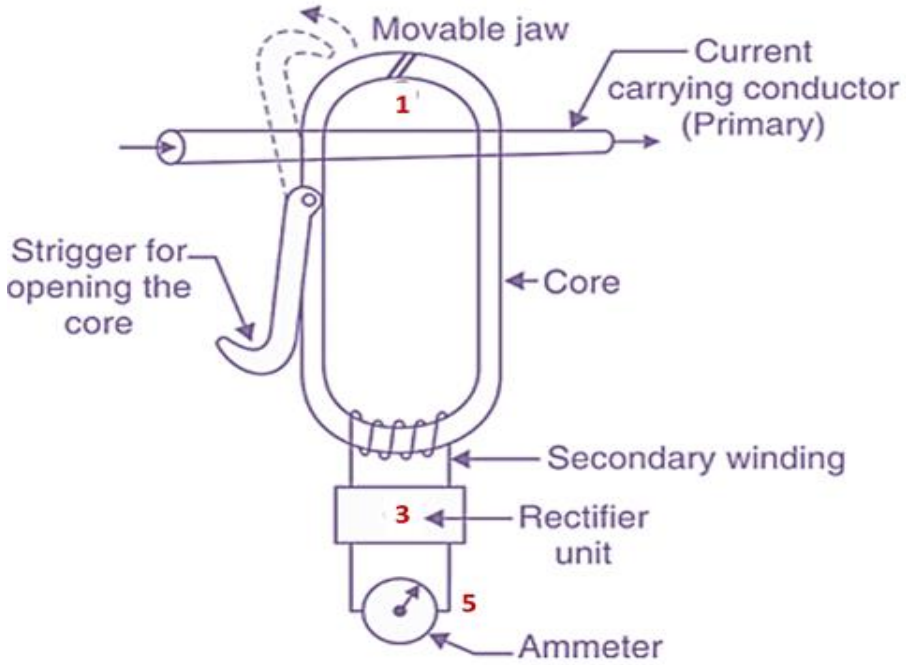
		parts	

OR Equivalent Answer/Points

b) Explain working of clamp on meter.

Ans:

Clamp On Meter:



2 Marks for diagram

Working of Clamp-on-meter:

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

2 Marks for working

c) State the necessity and construction of earth tester with suitable sketches.

Ans:

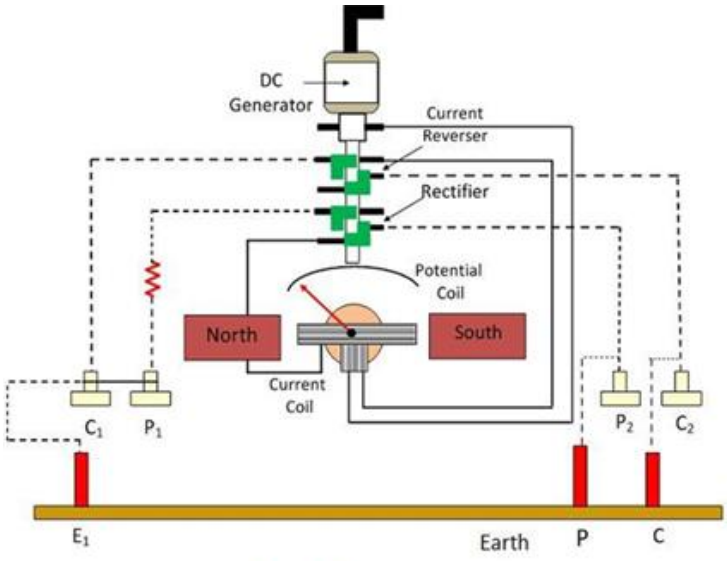
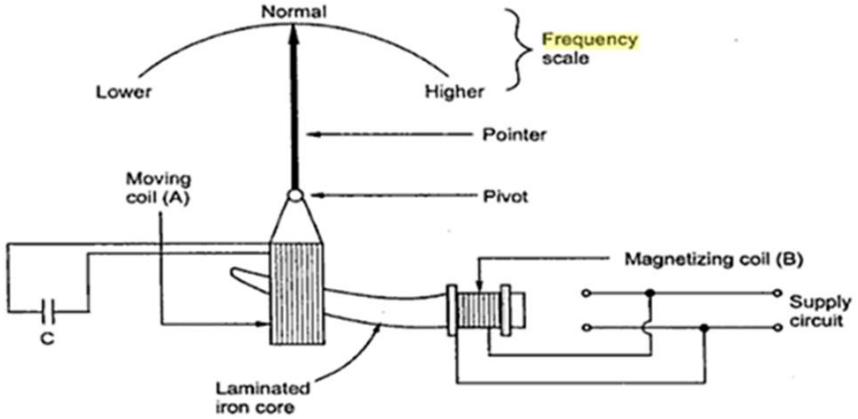
Necessity of Earth Tester:

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 P1, C1, P2 and C2. 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.  Earth Tester	1 Mark 2 Marks for diagram
	d)	List out various frequency meter and explain any one of them. **Ans:** **List of Various Frequency Meter:** 1. Electrical resonance (or Ferro dynamic) type frequency meter. 2. Weston type frequency meter. 3. Digital / Electronic type frequency meter. 4. Mechanical resonance (or Vibrating reed) type frequency meter. 5. Ratio-meter type frequency meter. 6. Saturable core type frequency meter. **Electrical Resonance (or Ferro Dynamic) Type Frequency Meter:** **Construction:**  Ferrodynamic frequency meter	½ Mark for each of any two = 1 Mark 1 Mark for diagram, 1 Mark for construction and 1 Mark for working of any one type

It consists of a fixed coil. The supply whose frequency is to be measured is connected across it. This coil is also known as magnetizing coil. It is mounted on a laminated iron core. The core has a typical varying cross section. It varies along the length and is maximum at the end of core. The moving coil of it is pivoted over the iron core. The pointer is fixed to the spindle of moving coil and the terminals of moving coil are connected to a suitable capacitor C. Here there is no controlling torque is required.

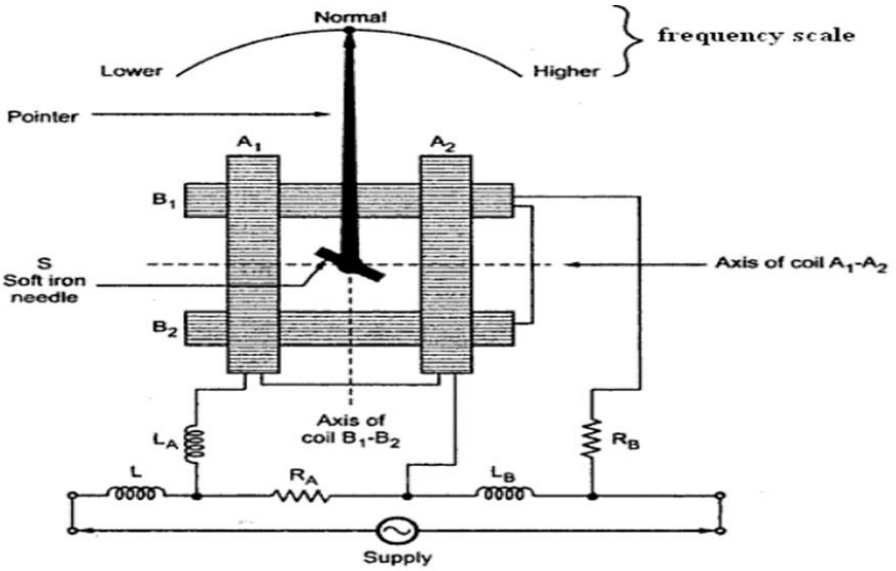
Working:

When the instrument is connected in the circuit, current flowing through magnetizing coil produces flux in the iron core which will set up an emf in the moving coil. This emf lags the flux ø by almost 90^0. This will cause current "I" to flow through capacitor C. If current is inductive it will lag induced emf and a torque will act on the coil and also if current is capacitive then the torque will act on the coil. But if the inductive reactance is equal to capacitive reactance then no torques will act on the moving coil hence current "I" is in phase with induced emf so this instrument is based on the principle of electrical resonance.

The capacitive reactance is constant for given frequency but the inductive reactance depends upon the position of pivoted coil on the core. The nearer the coil approaches the magnetizing coil, the greater is its inductance. The moving coil is pulled towards magnetizing coil until both reactance are exactly equal. i.e. when torque is zero. The value of capacitor C is so selected that the moving coil takes up convenient position when frequency is of normal value. If the supply frequency is more, the capacitive reactance (1/2πfc) decreases. In order that the inductive reactance is again try equal to capacitive reactance the inductance of coil must decrease so the moving coil thus moves away from magnetizing coil till resonance condition showing higher frequency on the scale and vice versa.

Weston Type Frequency Meter:

Construction:



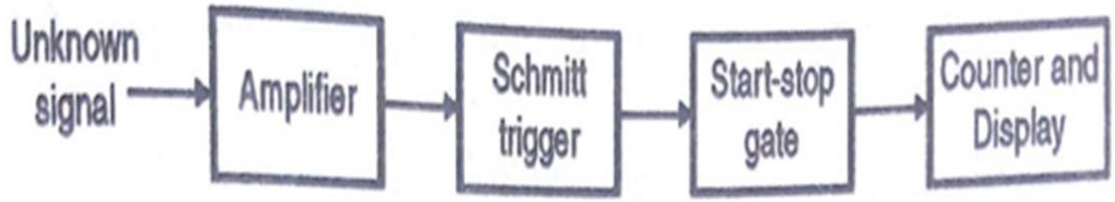
As shown in bellow diagram there are two coils A_1-A_2 & B_1-B_2 divided into two sections & perpendicular to each other. In the circuit of coil A (A_1-A_2) there is series combination of resistance R_A and reactance L_A in parallel with it. While in the circuit of coil B (B_1-B_2) there is series combination 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.

Working:

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 LA and RB 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. 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.

Digital / Electronic Type Frequency Meter:



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.

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 frequency of unknown signal is measured.

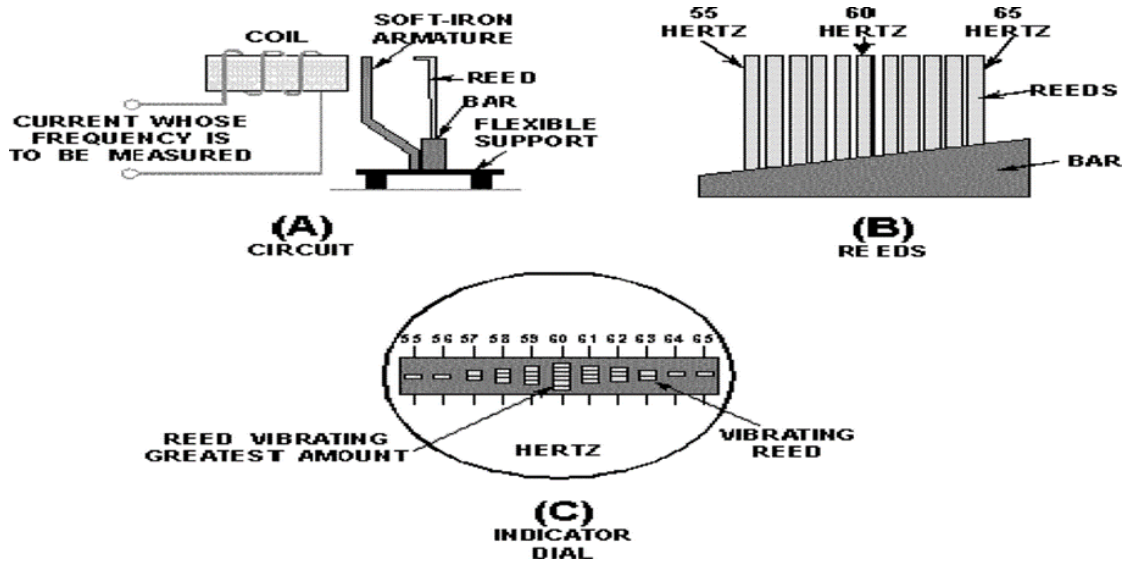
Now, $f = N / t$

Where, f = unknown frequency

N = No. count displayed on counter and

t = time interval between start and stop condition of the gate.

Reed type frequency meter:



When the instrument is connected across the supply whose frequency is to be measured, an alternating flux is set up. Due to this flux an attractive force is experienced upon the reeds after every half cycle. Consequently, the reeds tend to vibrate but only the reed whose actual frequency is double of supply frequency will be in resonance and vibrate with maximum amplitude normally the vibration other reeds is so slight as to be unobservable.

OR Equivalent Answer

4. Attempt any THREE of the following: 12 Marks

a) Compare analog ammeter and voltmeter on the basis of following points:
i) Connection in the circuit.
ii) Resistance.
iii) Circuit symbol.
iv) Extension of range

Ans:

Comparison Between Analog Ammeter and Voltmeter:

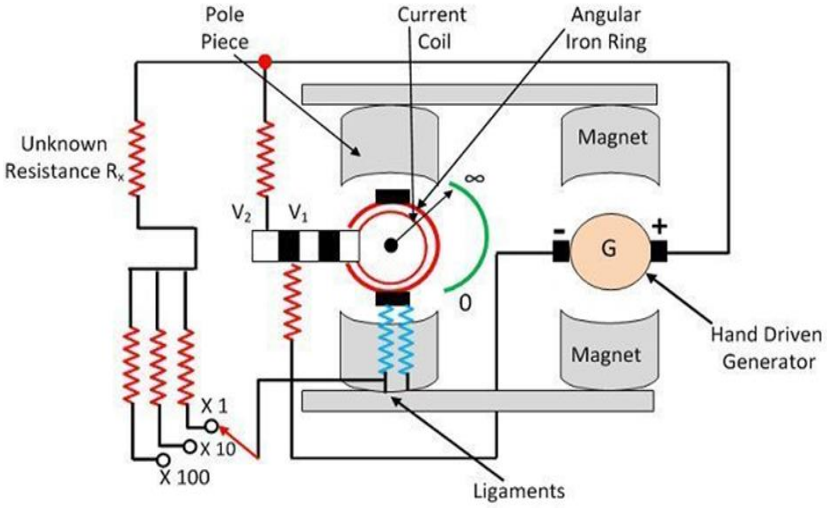
Sr. No.	Particulars	Ammeter	Voltmeter
1.	Connection in the circuit	Connected in series with the load	Connected in parallel with / across the load
2.	Resistance value	Very low	Very high
3.	Circuit symbol		
4.	Extension of range	By using Current transformer or By using shunt	By using Potential Transformer or By using multiplier

1 Mark for each of any four points = 4 Marks

b) Explain application of measurement system.

Ans:

		Application of Measurement System: **1. Comparison / Modification:** 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. **2. Monitoring of Process and Operation:** 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. **3. Control of Process and Operations:** Through measurement process, unknown quantity is compared with predetermined standard values and one can convert physical parameter to meaningful quantity. Automatic control system a very strong association between measurement and control for example -refrigeration with thermostatic control. **4. Experimental Engineering Analysis:** Measurements are very much applicable to solve engineering problems, theoretical and experimental methods may be used depending upon the nature of the problem. Measurements help in achieving goals and objectives of engineering because of the feedback information supplied by them. By using measurement system different engineering analysis are done, such as theoretical and experimental problems. **OR Equivalent Answer/Points**	1 Mark for each of any four points = 4 Marks
	c)	Two wattmeters connected to measure the input to a balanced 3-ph circuit indicate 2000 watt and 500 watt respectively. Find the power factor of circuit, when both reading are positive. **Ans:** **Given-Data:** W_1 = 2000 watt, W_2 = 500watt, Balanced three phase circuit. $\text{Pf} = \cos\emptyset = \cos\left[\tan^{-1}\frac{\sqrt{3}(W1-W2)}{(W1+W2)}\right]$ $= \cos\left[\tan^{-1}\frac{\sqrt{3}(2000-500)}{(2000+500)}\right]$ = Cos 46.10 **Power factor = 0.693**	1 Mark 1 Mark 1 Mark 1 Mark
	d)	State need and construction of megger with suitable sketches. **Ans:** **Need of Megger:** Megger is used for the measurement of insulation resistance. **Construction of Megger:**	1 Mark



1.5 Marks for diagram

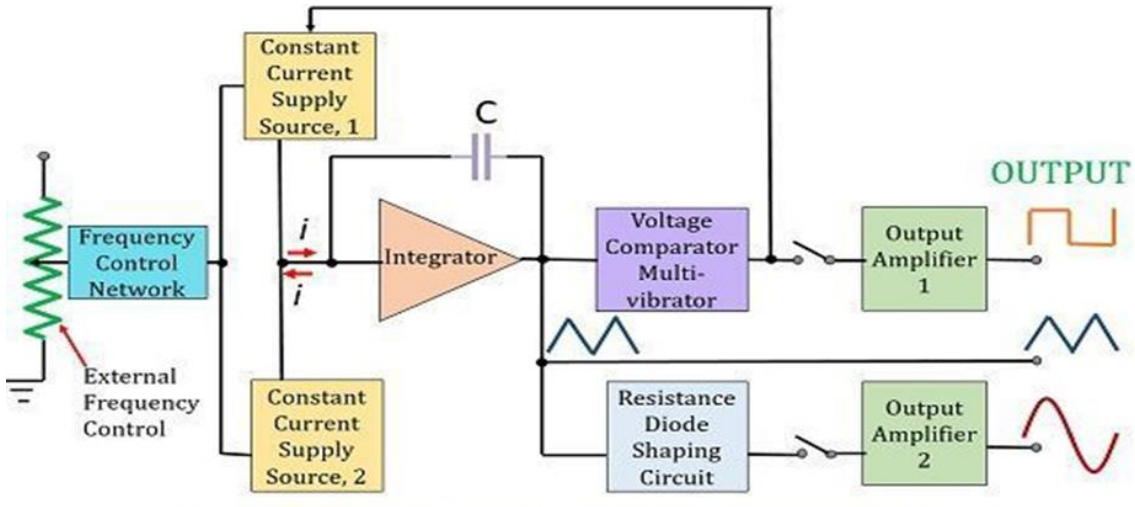
Two coils, the current coil and pressure coil are mounted at an angle on the same spindle and form the part of the moving system. These coils are connected to a small hand driven generator, with polarities such that torque produced by them will act in opposition to each other. The coils being placed 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.

1.5 Marks for construction

e) Explain with neat diagram working of function generator.

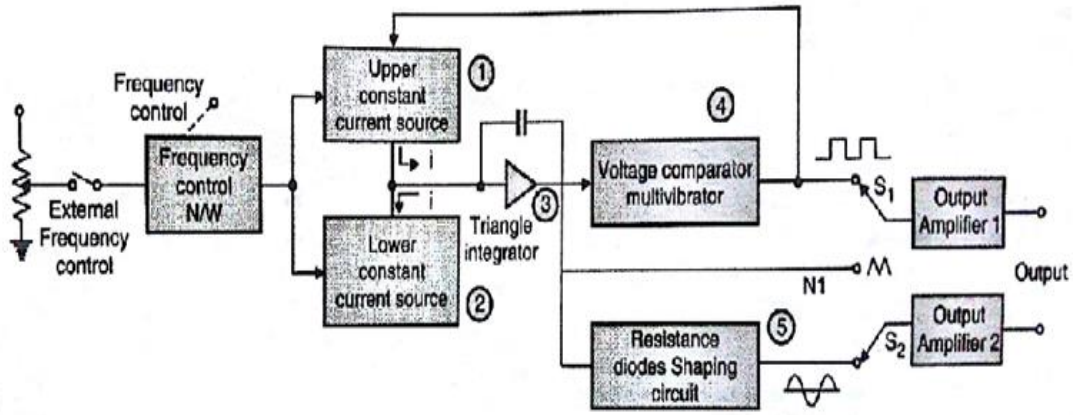
Ans:

Working of Function Generator:



2 Marks for diagram

OR



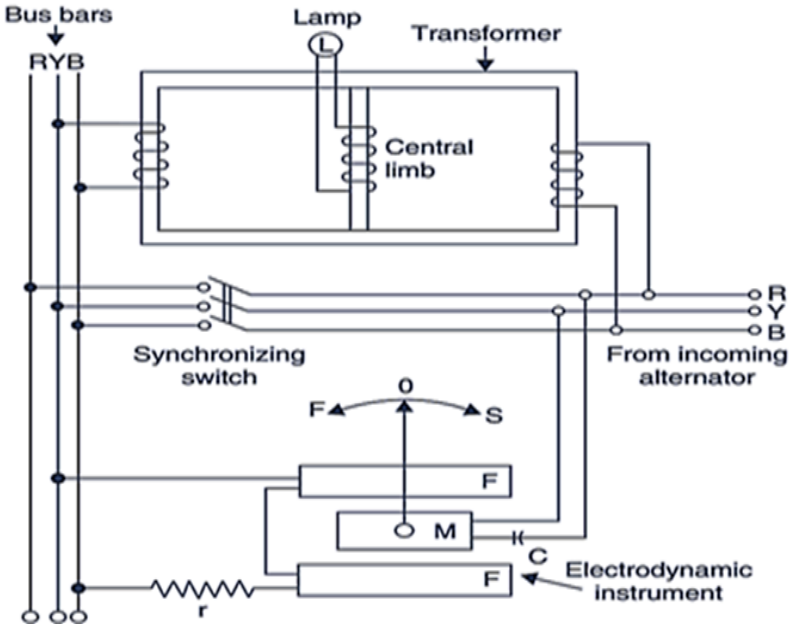
Working of Function Generator:

- 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 integrator so that its output voltage reaches a predetermined level on the negative slope of the integrator's output voltage.
- Thus have a triangular wave at the output of the integrator whose frequency depends on current by the supply sources as in the block diagram shown. A square wave signal is obtained at the output of the comparator.
- The resistance diode network employed in the circuit changes the slope of that triangular wave with distortion less than 1%. The output amplifier thus helps to provide two waves at the output simultaneously. This captured signal can be displayed by using an oscilloscope.

2 Marks for working

5		**Attempt any <u>TWO</u> of the following:**	**12 Marks**
5	a)	Explain with labeled sketches the construction and working of synchroscope. **Ans:** There are two types of synchroscope as: 1) Electrodynamometer type synchro-scope and 2) Moving iron type synchro-scope **(Student can attempt any one of them so it can be considered)** **1. Electrodynamometer type Synchro-scope:** **Construction:** It consists of a three-limb transformer and electrodynamic instrument. The winding on one outer limb is connected with the bus bars and the winding on other outer limb is connected with the incoming alternator. The winding on the central limb of the transformer is connected to a lamp. The windings or outer limbs produce two fluxes, which flow through the central limb, where the resultant flux is obtained which is the phasor sum of the two fluxes. This	2 Marks for construction of any one type

resultant flux induces an emf in the central limb winding. The electrodynamic instrument consists of two fixed coils FF and a moving coil M. The moving coil carries a pointer which moves on the scale showing fast / slow.



2 Marks for diagram of any one type

Working:

The outer windings are so arranged / connected that when the voltages of bus bar and of the incoming alternator are in phase, the two fluxes in the central limb are added up and induced emf in the central limb is maximum as a result the lamp glows with maximum brightness. When the two voltages are 1800 out of phase, the resultant flux is zero so no emf is induced in the central limb winding, thus lamp does not glow at all. If the frequency of incoming alternator is different from the supply frequency of bus bars, the will flicker and the frequency of the flickering is equal to the difference of the two frequencies. But the flickering of lamp cannot indicate whether the incoming alternator is fast or slow. For this purpose, an electrodynamic instrument is provided with arrangement as shown in figure. The fixed coils (FF) carry small current and are connected across any two bus bars through resistance r. The moving coil (M) is connected across the incoming alternator through a capacitor C. The correct instant of synchronizing is that where the pointer is visible at its central position and is moving very slowly.

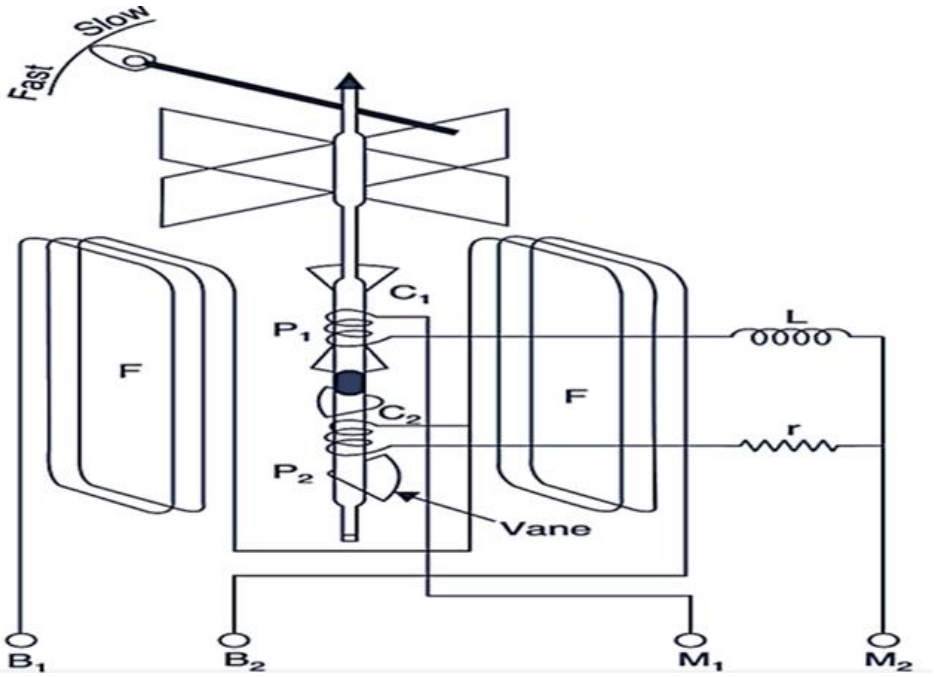
2 Marks for working of any one type

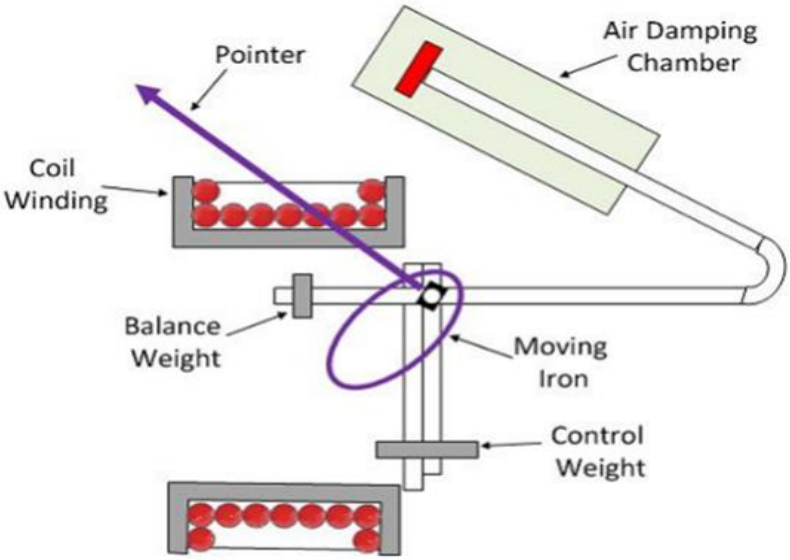
OR

2. Moving Iron type Synchro-scope:

Construction:

This consists of a fixed coil in two parts (FF) which are designed for a small current and are connected across two phases of the bus bars as shown in figure. There are two iron cylinders C_1 and C_2 mounted on a spindle and are separated by spacers. Each cylinder is provided with two iron vanes whose axes are 180^0 apart. The cylinders are excited by two pressure coils P1 and P2 which are connected to two phases of the incoming alternator. One pressure coil has a resistance r and other has an inductance L connected in series to establish almost 90^0 phase

		difference between their currents. The pointer attached with the spindle moves over a dial marked as fast & slow.  **Working / Operation:** When the frequency of the incoming alternator is same as that of bus bars, the instrument behaves as a PF meter. The movement of the pointer is equal to the phase difference between the two voltages. The pointer does not deflect at all if there is no phase difference between the two voltages. When two frequencies are different, pointer moves at a speed corresponding to the difference in the frequencies. The direction of motion of the pointer shows whether the alternator is fast or slow. When the pointer is at zero, the synchronizing switch is closed. The MI synchroscope are more common in use. They are economical and have long scale spread over 360^0	
5	b)	Explain the working of PMMI instrument with neat diagram. **Ans:** There are two types of MI instrument: 1) Attracted type 2) Repulsive type **(Student can attempt any one of them so it can be considered)** **Attraction Type MI Instrument:** **Working:** When the instrument is connected in the circuit, the operating current flows through the coil. This current sets up the magnetic field (it becomes electromagnet) and therefore an oval shaped moving iron moves from weaker field outside the coil to the stronger field inside the coil in other words the moving iron is attracted to inward side of coil. The result is that the pointer attached to the moving system moves from zero position on graduated scale. If the current in the coil is reversed, polarity of poles changes but even then the coil become an electromagnet and attracts the iron piece inwards of coil therefore the direction of deflecting torque remains unchanged, hence such instruments can be used for both D.C. as well as A.C. measurements. The controlling torque is provided by gravity control and the damping torque is provided by air friction damping.	3 Marks for working of any one type



Attraction Type Moving Coil Instrument

3 Marks for diagram of any one type

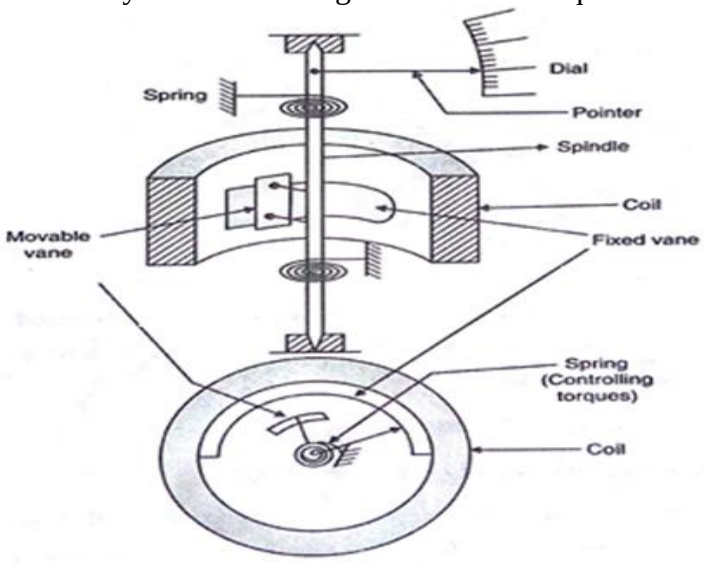
OR

Repulsion Type MI Instrument:

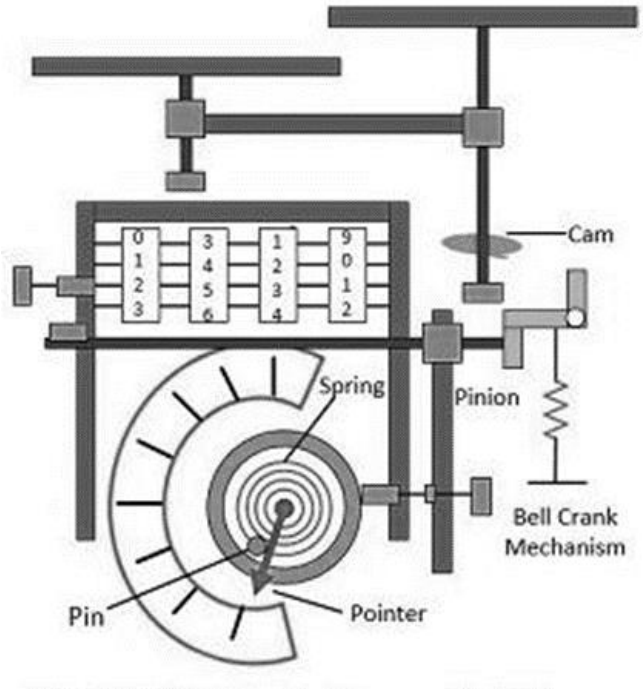
Working:

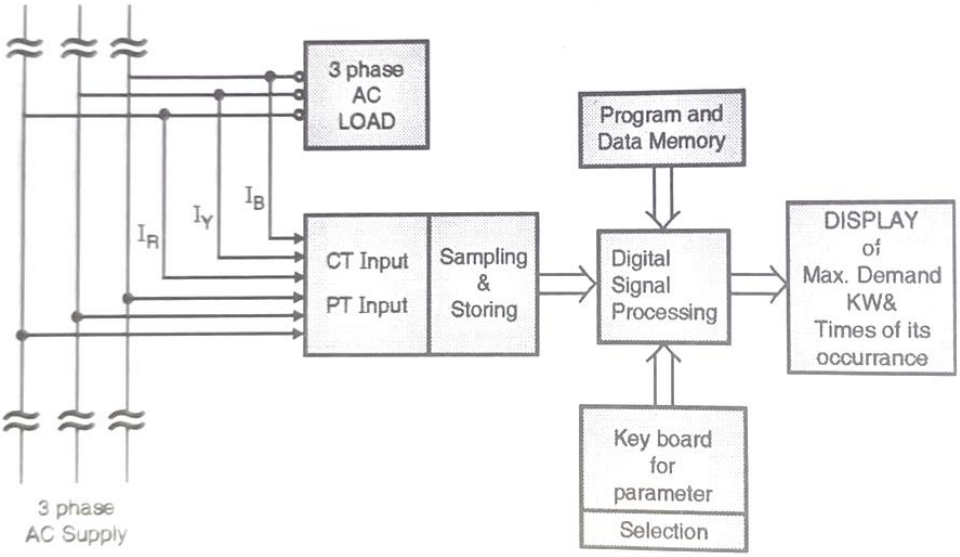
It consists of fixed cylindrical hollow coil which carries operating current. Inside the coil, there are two soft iron pieces. One of which is fixed other is movable. The fixed iron piece is attached to the coil whereas the movable iron piece is attached to spindle. Under action of deflecting torque,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

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 deflecting force becomes equal to the controlling force.

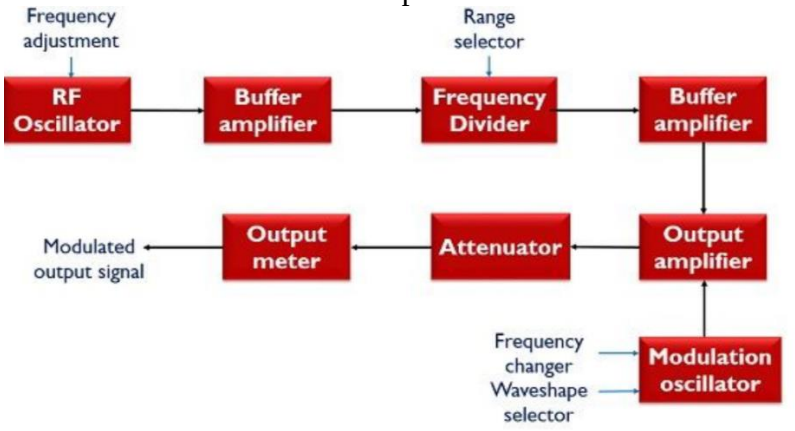


Repulsion Type MI Instrument

5	c)	**Explain working of maximum demand indicator with a neat sketch** **Ans:** There are two types of maximum demand indicators: 1) Analog (Average or Merz – price) type maximum demand indicator and 2) Digital type maximum demand indicator **(Student can attempt any one of them so it can be considered)** **Working of Analog (Average or Merz – price) type Maximum Demand Indicator:** It consists of a separate dial mechanism whose pointer is driven by a pin and gear train arrangement which is coupled to the spindle of the moving system of the meter as shown in the figure below. The system is provided with a reset device, which brings back the pin to its zero position after each integrating period. The pointer is provided by a special friction mechanism, which makes the pointer stay at the same previously indicated position even after the reset of pin position. It means the pointer moves in the forward direction only when the power consumption during that time period is more than its previous maximum value where the pointer is resting. The reset device consists of a cam, which is controlled by a timing gear. After each integrating period, it isolates the pinion and moving system with the help of a bell crank. During this small isolation period, the pin returns to its zero position due to the action of the spiral spring.  The energy consumed for an integrating time period (15 or 30 minutes) is indicated by the pointer on the dial. The pointer is driven by the pin. After this time period, the reset device comes into action and makes the pin return to its zero position. But the pointer continues to indicate the same reading. The pin starts indicating the energy consumed in the next time period. If this consumption increases beyond the previous consumption value, which is being indicated by the pointer then only the pointer moves further, otherwise, it will be stable at the same position. The Merz-Price maximum demand indicator is also known as average demand indicator. **OR**	3 Marks for working of any one type 3 Marks for diagram of any one type

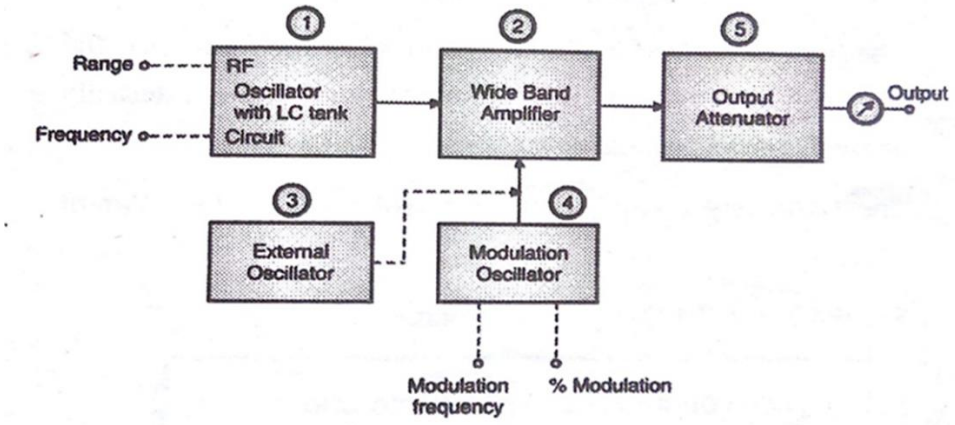
		Working of Digital type Maximum Demand Indicator:  1. The three phase load voltage and load current are provide to sampling and storing circuit through PT and CT. 2. Sample and store circuit is used to take a changing analog signal and literally hold it so that the further circuit or system such as an ADC, (Analog to Digital Converter) has the necessary time it needs to process it.. 3. Digital voltage and current samples are further processed by digital signal processing unit as per program instructions and set parameters for maximum value to be indicated by digital display. 4. The display of any or all of these powers can be done for their present status or past status along with the time of occurrence. 5. A suitable sorting algorithm present in program memory of instrument loads maximum power data values in the reserved memory locations along with their time of occurrence. 6. Each time the present value of power is compared by the algorithm with the past maximum power value and the maximum power value is revised if it is needed. 7. This instrument can store / record the readings, it has facility to change the program, set parameters as per required measurements. **OR Equivalent Answer**	
6		**Attempt any TWO of the following:**	**12 Marks**
6	a)	Describe with sketches the various blocks and working of signal generator. **Ans:** **Working of Signal Generator:** • It consists of RF oscillator which is placed at the beginning of the arrangement. This oscillator generates a carrier signal having a frequency range 100 kHz to 30 MHz. The frequency of this carrier signal can be varied by making use of a selector switch. The modulation oscillator is placed that produces a modulating signal. The two input lines are provided in this modulation oscillator. One is for frequency or amplitude adjustment and other is for the selection of waveform. This waveform selector is basically used to have sinusoidal or non-sinusoidal waveforms at the output.	3 Marks for working of any one type

- The radio frequency carrier signal through a buffer amplifier is fed to an output amplifier along with modulating frequency signal. This output amplifier is a wideband amplifier. So, the generated signal gets amplified in the output amplifier. So basically, buffer amplifier acts as an isolator in order to provide good isolation between the oscillator and output amplifier. This reduces the effects of distortion in the generated signal.
- This amplified output is then given to an attenuator, which adjusts voltage of the signal which is then given to the output through an output meter, which measures output and gives feedback in order to maintain the output.



Block diagram of Signal Generator

OR



3 Marks for diagram of any one type

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.

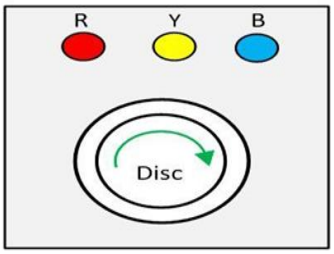
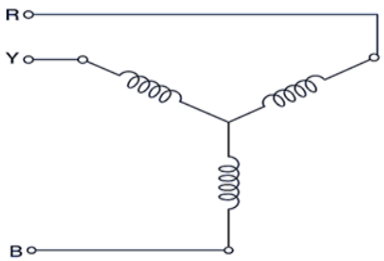
The frequency of oscillation is selected from the frequency range control and the vernier dial setting on the front panel. The modulation is indicated by meter.

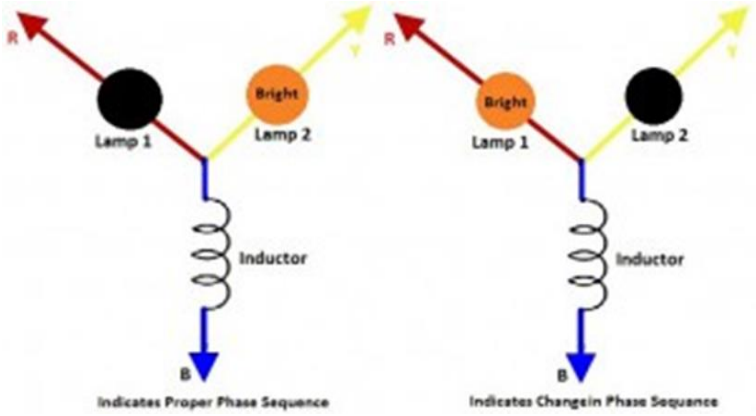
The output signal can be AM (Amplitude Modulated) or FM (Frequency Modulated). Modulation can be done by sine wave, square wave or triangular wave or by pulse.

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.

OR Equivalent Answer

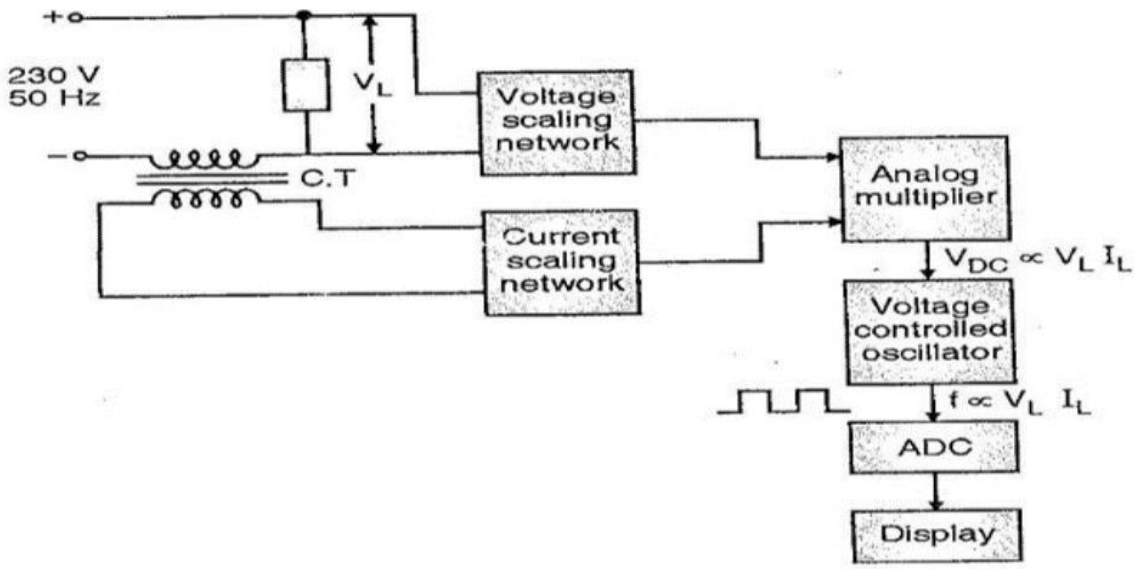
6	b)	Explain the working principle of phase sequence indicator with relevant constructional diagram. **Ans:** There are two types of phase sequence indicators: 1) Rotating type phase sequence indicator and 2) Static type phase sequence indicator. **(Student can attempt any one of them so it can be considered)** **Working Principle of Rotating type Phase Sequence Indicator with Relevant Constructional Diagram:** 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.  Rotating Type Phase Sequence Indicator Circuit Globe  **Working Principle of Static type Phase Sequence Indicator with Relevant Constructional Diagram:** Connect two lamps, lamp1 to R-phase, lamp2 to Y-phase and inductor to B-phase as shown in the bellow figure. Resistors are connected in series with the lamps for protecting the lamps from over currents and breakdown voltages. The device whose phase sequence is used to be known is connected to the static phase sequence indicators. 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 2.	3 Marks for explanation of any one type 3 Marks for diagram of any one type



6 c) Describe the working of 1-phase electronic energy meter with relevant sketch and compare it with 3-phase energy meter.

Ans:

Working of 1-phase Electronic Energy Meter:



2 Marks for diagram

1. The single-phase load voltage and load current are sensed and then downscaled using the voltage and current scaling networks and applied to analog multiplier.
2. Analog multiplier gives dc voltage proportional to the product of the voltage and current drawn (i.e. power drawn) from supply.
3. The voltage-controlled oscillator (VCO) is basically a voltage to frequency converter. The output of VCO is a square wave the frequency of which is proportional to its input (which is proportional to power).
4. The analog signal at the output of VCO is converted into digital signal by means of ADC.
5. The analog to digital convertor (ADC), output is digital output which is applied to display unit, which actually measures the frequency proportional to the power over the particular time period then power gets converted into energy.

2 Marks for working

		Comparison Between Single Phase and Three Phase Energy Meter: • The flow of electricity in a single-phase connection is through a single conductor whereas, in a three-phase connection, there are three separate conductors for electric transmission. • In a single-phase meter system, the upper limit of the voltage can be 230 Volts whereas, in a three-phase system, the upper limit can be 415 Volts as well. • Two separate wires are mostly required in a single-phase meter for smooth electricity flow. But in a three-phase meter, the circuit can be completed with three-phase wires and one neutral wire. • A three-phase meter transfers minimum electrical energy as compared to the single-phase power meters. • There are two wires in a single-phase electric meter which makes it a simple network. But in a three-phase meter, there are four different wires that make the network complicated. • Since there is only one phase in a single-phase meter, any unforeseen event in the network interrupts the entire power supply. On the other hand, in a three-phase meter, if one phase doesn't work, other phases compensate for it, thereby eliminating the chances of power interruption. • A single-phase power meter is less efficient than a three-phase connection since the latter needs fewer conductors unlike the former one for the same circuit.	½ Mark for each of any four points = 2 Marks