**

**Rajasthan Institute of Engineering & Technology, Jaipur.**

**I Mid Term examination**

**Session: 2017-18**

**Semester:-IV & Branch:-EE/EEE**

**Subject: Electrical Measurement**

SET- B

Time: 2 hrs. M.M.:20

**Q.1 Explain the construction of PMMC instrument.**

**Answer 1:-Controlling Torque**

This torque is produced by the spring action and opposes the deflection torque so as the pointer can come to rest at the point where these two torques are equal (Electromagnetic torque = control spring torque). The value of control torque depends on the mechanical design of spiral springs and strip suspensions.

The controlling torque is directly proportional to the angle of deflection of the coil.

Control torque Ct =Cθ where, θ = deflection angle in radians and C = spring constant Nm /rad .

**Damping torque**

This torque ensures the pointer comes to an equilibrium position i.e. at rest in the scale without oscillating to give an accurate reading. In PMMC as the coil moves in the magnetic field, eddy current sets up in a metal former or core on which the coil is wound or in the circuit of the coil itself which opposes the motion of the coil resulting in the slow swing of a pointer and then come to rest quickly with very little oscillation.

**Construction**

A coil of thin wire is mounted on an aluminum frame (spindle) positioned between the poles of a U shaped permanent magnet which is made up of magnetic alloys like alnico.

The coil is pivoted on the jeweled bearing and thus the coil is free to rotate. The current is fed to the coil through spiral springs which are two in numbers. The coil which carries a current, which is to be measured, moves in a strong magnetic field produced by a permanent magnet and a pointer is attached to the spindle which shows the measured value.

**Q.2 What is working principle of Electrodynamometer instrument.**

**Answer 2:-**The necessity for the a.c. calibration of moving iron instruments as well as other types of instruments which cannot be correctly calibrated requires the use of a transfer type of instrument. A transfer instrument is one that may be calibrated with a d.c. source and then used without modification to measure a.c. This requires the transfer type instrument to have same accuracy for both d.c. and a.c., which the electrodynamometer instruments have.

These standards are precision resistors and the Weston standard cell (which is a d.c. cell).It is obvious, therefore, that it would be impossible to calibrate an a.c. instrument directly against the fundamental standards. The calibration of an a.c. instrument may be performed as follows. The transfer instrument is first calibrated on d.c. This calibration is then transferred to the a.c. instrument on alternating current, using operating conditions under which the latter operates properly. Electrodynamic instruments are capable of service as transfer instruments. Indeed, their principal use as ammeters and voltmeters in laboratory and measurement work is for the transfer calibration of working instruments and as standards for calibration of other nstruments as their accuracy is very high. Electrodynamometer types of instruments are used as a.c. voltmeters and ammeters both in the range of power frequencies and lower part of the audio power frequency range. They are used as watt-meters, and with some modification as power factor meters and frequency meters.



## Operating Principle of Electrodynamometer Type Instrument

It would have a torque in one direction during one half of the cycle and an equal effect in the opposite direction during the other half of the cycle. If the frequency were very low, the pointer would swing back and forth around the zero point. However, for an ordinary meter, the inertia is so great that on power frequencies the pointer does not go very far in either direction but merely stays (vibrates slightly) around zero. If, however, we were to reverse the direction of the flux each time the current through the movable coil reverses, a unidirectional torque would be produced for both positive and negative halves of the cycle.

In electrodynamometer instruments the field can be made to reverse simultaneously with the current in the movable coil if the field (fixed) coil is connected in series with the movable coil.

**Q.3 What is construction of Electrodynamometer instrument.**

## Answer 3:-Construction of Electrodynamometer type instrument

## Fixed Coils

The field is produced by a fixed coil.

This coil is divided into two sections to give a more uniform field near the centre and to allow passage of the instrument shaft.

## Moving Coil

A single element instrument has one moving coil.

The moving coil is wound either as a self-sustaining coil or else on a non-metallic former.

A metallic former cannot be used as eddy current would be induced in it by the alternating field.

Light but rigid construction is used for the moving coil.

It should be noted that both fixed and moving coils are air cored.

## Control

The controlling torque is provided by two control springs. These springs act as leads to the moving coil.

## Moving System

The moving coil is mounted on an aluminum spindle.

The moving system also carries the counter weights and truss type pointer.

Sometimes a suspension may be used in case a high sensitivity is desired.

## Damping

Air friction damping is employed for these instruments and is provided by a pair of aluminum vanes, attached to the spindle at the bottom.

These vanes move in sector shaped chambers.

Eddy current damping cannot be used in these instruments as the operating field is very weak (on account of the fact that the coils are air cored) and any introduction of a permanent magnet required for eddy current damping would distort the operating magnetic field of the instrument.

## Shielding

The field produced by the fixed coils is somewhat weaker than in other types of instruments

It is nearly 0.005 to 0.006 Wb/m

In d.c. measurements even the earth magnetic field may affect the readings.

Thus it is necessary to shield an electrodynamometer type instrument from the effect of stray magnetic fields.

Air cored electrodynamometer type instruments are protected against external magnetic fields by enclosing them in a casing of high permeability alloy.

This shunts external magnetic fields around the instrument mechanism and minimizes their effects on the indication.

## Cases and Scales

Laboratory standard instruments are usually contained in highly polished wooden cases.

These cases are so constructed as to remain dimensionally stable over long periods of time.

The glass is coated with some conducting material to completely remove the electrostatic effects.

The case is supported by adjustable leveling screws.

A spirit level is also provided to ensure proper leveling.

The scales are hand drawn, using machine sub-dividing equipment. Diagonal lines for fine sub-division are usually drawn for main markings on the scale.

Most of the high-precision instruments have a 300 mr scale with 100, 120 or 150 divisions.

**Q.4 Explain the working of PMMC instrument.**

**Answer 4:-**

**Q.5 Explain the Errors of Electrodynamometer instruments.**

**Answer 5:-**Errors in Electrodynamometer Instruments

The various errors in electrodynamometer instruments are,

**1. Torque to weight ratio** : To have reasonable deflecting torque, mmf of the moving coil must be large enough. Thus m.m.f. = NI hence current through moving coil should be high or number of turns should be large. The current cannot be made very high because it may cause excessive heating of springs. Large number of turns hence is the only option but it increases weight of the coil. This makes the system heavy reducing torque to weight ratio. This can cause frictional errors in the reading.

**2. Frequency errors** : The changes in the frequency causes to change self inductances of moving coil and fixed coil. This causes the error in the reading. The frequency error can be reduced by having equal time constants for both fixed and moving coil circuits.

**3. Eddy current errors** : In metal parts of the instrument the eddy current gets produced. The eddy current interacts with the instrument current, to cause change in the deflecting torque, to cause error. Hnec metal parts should be kept as minimum as possible. Also the resistivity of the metal parts used must be high, to reduce the eddy currents.

**4. Stray magnetic field error** : Similar to moving iron instruments the operating field in electrodynamometer instrument is very weak. Hence external magnetic field can interact with the operation field to cause change in the deflection, causing the error. To reduce the effect of stray magnetic field, the shields must be used for the instruments.

**5. Temperature error**: The temperature errors are caused due to the self heating of the coil, which causes change in the resistance of the coil. Thus temperature compensating resistors can be used in the precise instrument to eliminate the temperature errors.

Q.6 Explain Advantage and Disadvantage of Electrodynamic instruments.

**Answer 6:-**

Advantages of Electrodynamic Instruments

1) As the coils are air cored, these instruments are free from hysteresis and eddy current losses.
2) They have a precision grade security.

3) These instruments can be used on both a.c. and d.c. They are also used as a transfer instruments.

4) Electrodynamometer voltmeter are very useful where accurate r.m.s values of voltage, irrespective of waveforms, are required.

5) Free from hysteresis errors.
6) Low power Consumption.
7) Light in weight.

Disadvantages of Electrodynamic Instruments

1) These instruments have a low sensitivity due to a low torque to weight ratio. Also it introduces increased frictional losses. To get accurate results, these errors must be minimized.

2) They are more expensive than other type of instruments.

3) These instruments are sensitive to overload and mechanical impacts. Therefore can must be taken while handling them.

4) They have a nonuniform scale.

5) The operation current of these instruments is large due to the fact that they have weak magnetic field.

**1. Electrodynamic Voltmeter**

• When the instrument is used as a ***voltmeter***, the fixed andmoving coils are joined in series (*I* = *I1* = *I2* ) along with ahigh resistance (R) and connected in parallel with the load.



1.The multiplier resistor is made of manganin or constantan.

2.When the total resistance of the coils and the required current for FSD are known, the multiplier resistance iscalculated exactly as for dc voltmeters.

3.The instrument scale can be read either as dc voltage or rms ac voltage.

4.An electrodynamic voltmeter is not suitable for measuring voltages in electronics circuits because of the loading effect.

