

S.E. Sem - IV - Instrumentation Q.P. Code - 25397
Subject: - Electrical Technology of Instruments - CBGS
Date: - 05/12/17.

- Q. 1 a) Types of D.C. motor with ~~a~~ circuit dia. & eqⁿ of each motor, - each type carries ~~1~~ 1 1/2 marks.
- b) Use of slip ring - 03 marks with dia.
brushes - 02 marks.
- c) Advantages of Bridge circuit -
Each carries 1 mark.
- d) Define sensitivity of voltmeter - 02 marks
~~with~~ Explanation with eqⁿ - 03 marks

Q. 2 a) Given

$$V = 230V, R_a = 0.25 \Omega, R_{sh} = 230 \Omega.$$

At no load condⁿ

$$I_{L0} = 3A$$

$$N_0 = 1100 \text{ rpm}$$

At full load condⁿ

$$I_{L1} = 41A$$

$$N_1 = ?$$

$$\rightarrow I_{sh} = \frac{V}{R_{sh}} = \frac{230}{230}$$

$$\underline{I_{sh} = 1A}, \text{ --- } 1M$$

Q. P. Code - 25397

$$I_{a0} = \text{Arm current at no load}$$

$$= I_{L0} - I_{sh}$$

$$= 3 - 1$$

$$\underline{I_{a0} = 2 \text{ A.} \quad \text{---} \quad \underline{0.2 \text{ M}}}$$

$$E_{b0} = V - I_{a0} R_a$$

$$= 230 - 2 \times (0.25)$$

$$\underline{E_{b0} = 229.5 \text{ V.} \quad \text{--- at no load,} \quad \underline{0.2 \text{ M}}}$$

Now at full load

$$I_{a1} = \text{Arm current}$$

$$= I_{L1} - I_{sh}$$

$$= 41 - 1$$

$$\underline{I_{a1} = 40 \text{ A} \quad \text{---} \quad \underline{0.1 \text{ M}}}$$

$$E_{b1} = V - I_{a1} R_a$$

$$= 230 - 40(0.25)$$

$$\underline{E_{b1} = 220 \text{ V.} \quad \text{--- at full load,} \quad \underline{0.2 \text{ M}}}$$

using speed eqⁿ

$$N \propto \frac{E_b}{\phi} \propto E_b$$

$$\therefore \frac{N_1}{N_0} = \frac{E_{b1}}{E_{b0}}$$

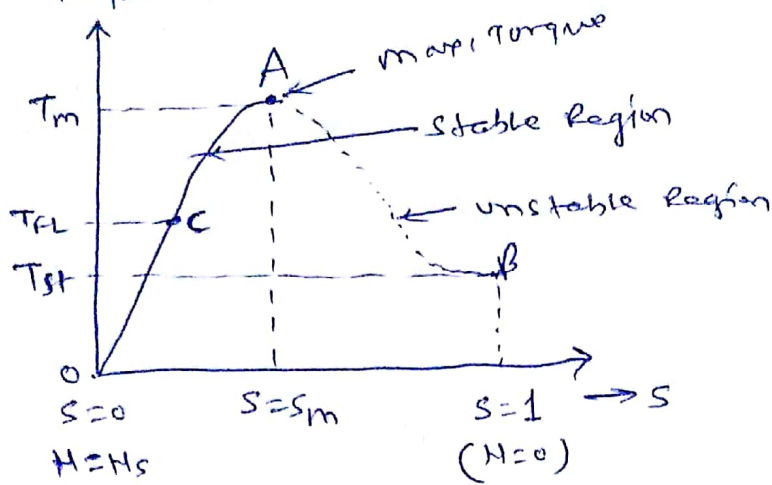
$$\therefore N_1 = \frac{220}{229.5} \times 1100$$

$$\boxed{N_1 = 1054.4 \text{ rpm}} \quad \text{--- is the}$$

Speed of motor at full load

2 b) Torque

Q P code - 25397



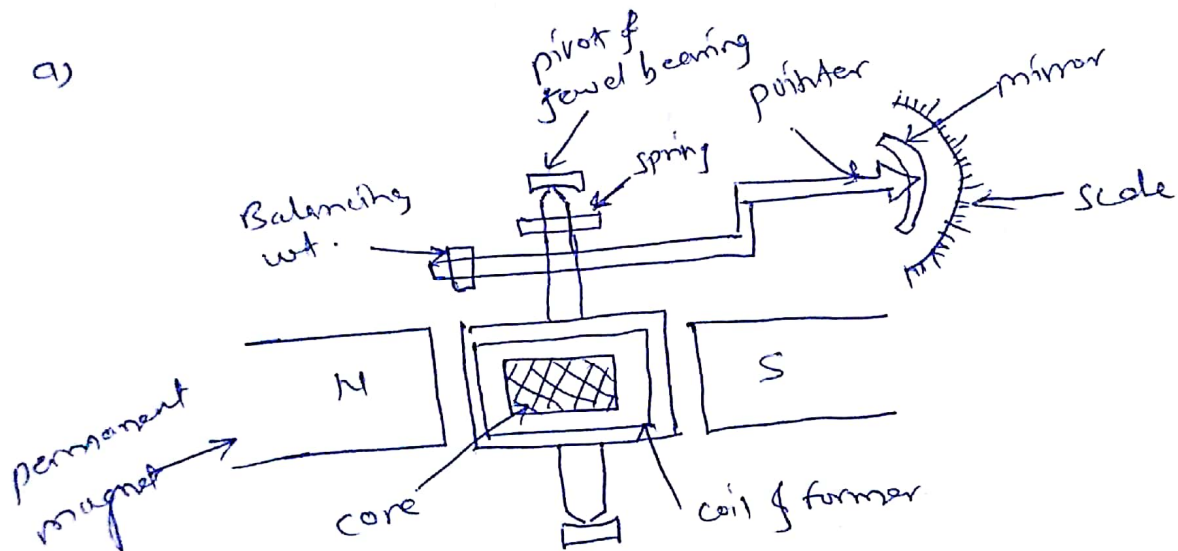
OA
AB
point A
point B
point C

- 03 marks

Torque slip characteristics.

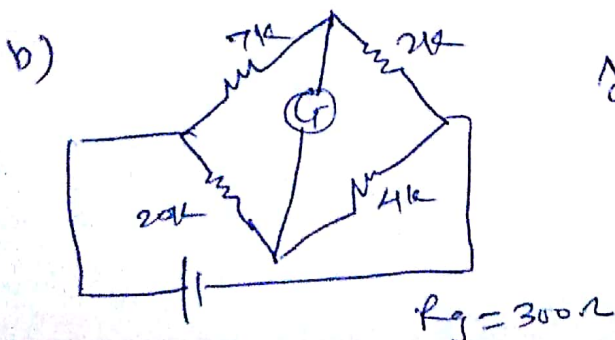
Explanation of each region of torque-slip ch' of above dia. - 07 marks.

Q 3 a)



construction of PMMC instrument dia - 03 M.

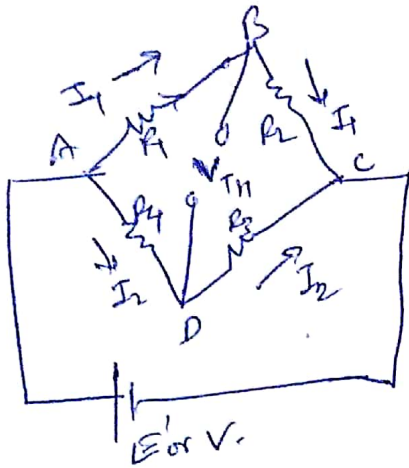
Explanation of above dia - 07 M.



Find $I_g = ?$

3/9

→ from Kq.



$$R_1 = 7k, R_2 = 2k, R_3 = 4k, R_4 = 20k$$

$$E/V = 8V.$$

use Thevening equivalent for I_g .

$$V_{TH} = V_{BD} = V_{AD} - V_{AB}$$

$$= I_2 R_4 - I_1 R_1$$

$$= \frac{E R_4}{R_3 + R_4} - \frac{E R_1}{R_1 + R_2}$$

$$= 8 \left[\frac{20}{20+4} - \frac{7}{7+2} \right]$$

$$\underline{V_{TH} = 0.444V} \quad \dots 05 M.$$

Thus ~~if~~ if B is the w.r.t. D

$$R_{eq} = [R_1 || R_2] + [R_3 || R_4] \quad \dots \text{with } E \text{ shorted}$$

$$= \frac{R_1 R_2}{R_1 + R_2} + \frac{R_3 R_4}{R_3 + R_4} = \underline{4.888k\Omega} \quad \underline{03 M}$$

$$\therefore I_g = \frac{V_{TH}}{R_{eq} + R_g} = \frac{0.444}{4.888 \times 10^3 + 300}$$

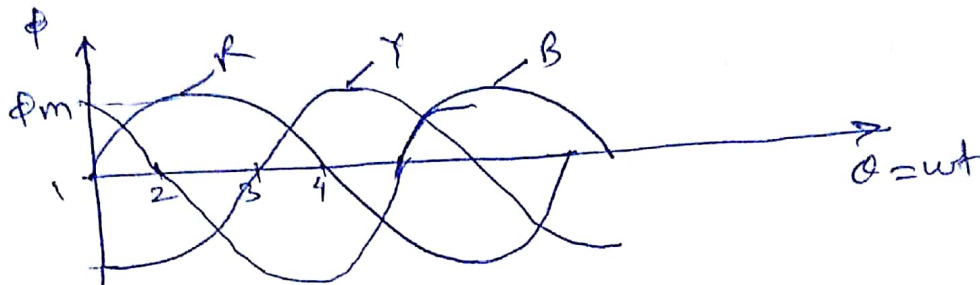
$$\underline{\text{Current thro' Galvano}} \quad \boxed{I_g = 85.62 \mu A} \quad \dots \underline{02 M.}$$

Q 4 a) Rotating magnetic field - 3 ϕ I.M. Q.P. Code 25397

$$\phi_R = \phi_m \sin(\omega t) = \phi_m \sin \theta.$$

$$\phi_Y = \phi_m \sin(\omega t - 120^\circ) = \phi_m \sin(\theta - 120^\circ)$$

$$\phi_B = \phi_m \sin(\omega t - 240^\circ) = \phi_m \sin(\theta - 240^\circ)$$

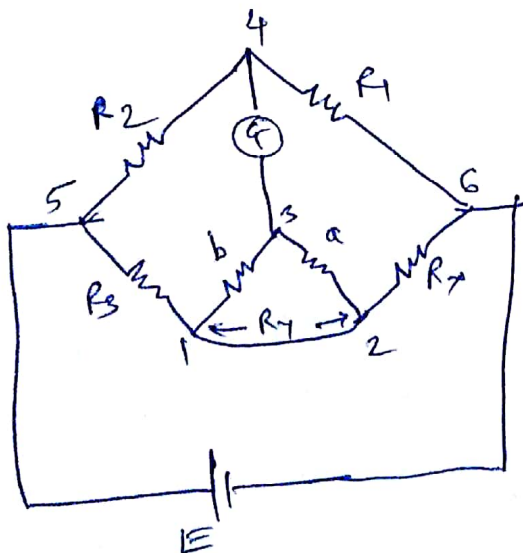


Waveform of 3 ϕ fluxes. --- 02 Marks.

using above eq^s of ~~the~~ w/f explain for
 $\theta = 0^\circ$, $\theta = 60^\circ$, $\theta = 120^\circ$, $\theta = 180^\circ$

Each case carries 2 marks. with phasor dia.

b) Kelvin's Double Bridge for low resistance measurement.



Kelvin's Double Bridge - 01 M

Q.P. code 25397 Q.P. code -25397
 from fig The galvanometer gives null indication when potential at 3 is same as the potential at terminal 4.

$$\therefore E_{45} = E_{513} \quad \text{--- (1)} \quad \therefore \frac{a}{b} = \frac{R_1}{R_2} \quad \text{--- (2)}$$

$$\therefore E_{45} = R_2 \cdot \frac{E}{R_1 + R_2} \quad \text{--- (3)}$$

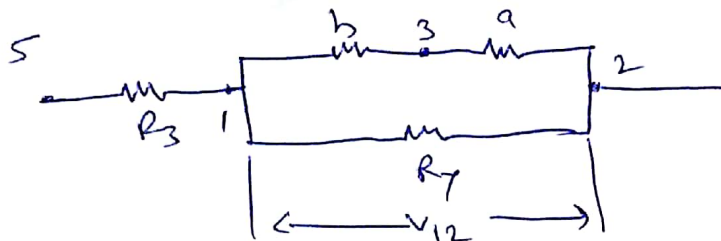
Now

$$E = I \times [R_3 + R_7 \parallel (a+b) + R_x]$$

$$E = I \left[R_3 + R_x + \frac{(a+b)R_7}{a+b+R_7} \right] \quad \text{--- (4)}$$

from eqⁿ (3)

$$E_{45} = \frac{R_2}{R_1 + R_2} I \left[R_3 + R_x + \frac{(a+b)R_7}{a+b+R_7} \right] \quad \text{--- (5)}$$



from above fig.

$$V_{12} = I \times \left[\frac{R_7 (a+b)}{R_7 + a+b} \right]$$

$$\therefore V_{13} = \frac{b}{a+b} \cdot V_{12}$$

$$V_{13} = \frac{b}{a+b} \cdot I \left[\frac{R_7 (a+b)}{R_7 + a+b} \right] \quad \text{--- (6)}$$

$$\therefore E_{513} = IR_3 + V_{13}$$

$$= I \left[R_3 + \frac{b}{a+b} \left(\frac{R_7 (a+b)}{R_7 + a+b} \right) \right] \quad \text{--- (7)}$$

Now

Eq 52E 513 . . . for Balancing. Q P code 25397

$$\frac{I R_2}{R_1 + R_2} \left[R_2 + R_x + \frac{(a+b) R_1}{a+b+R_1} \right] = I \left[R_2 + \frac{b}{a+b} \left(\frac{R_1 (a+b)}{a+b+R_1} \right) \right]$$

Simplify of separate real & imaginary terms

$$R_x = \frac{R_1 R_2}{R_2} + \frac{b \cdot R_1}{R_1 + a + b} \left[\frac{R_1}{R_2} - \frac{a}{b} \right] \quad \text{--- (8)}$$

$$\text{But } \frac{a}{b} = \frac{R_1}{R_2} \therefore \frac{R_1}{R_2} - \frac{a}{b} = 0$$

$$\therefore \boxed{R_x = \frac{R_1 R_2}{R_2}} \quad \text{--- (9)}$$

Each eqⁿ carries 1 mark.

Q. 5 b) Losses in Induction motor

- 1) constant losses
- 2) variable losses

Explanation of each above is 5 m.

Q. 5 a) 3 ϕ , 4 pole, 50 Hz IM

$$E_2 = 121 \text{ V}$$

$$R_2 = 0.3 \Omega$$

$$X_2 = 0.8 \Omega$$

$$I_{2r} = 15 \text{ A}$$

$$I_{2r} = \frac{E_2 r}{Z_{2r}} = \frac{S \cdot E_2}{\sqrt{R^2 + (S \times X_2)^2}} \dots \dots \underline{3M}$$

$$\therefore 15 = \frac{5 \times 121}{\sqrt{(0.3)^2 + (S \times 0.8)^2}}$$

$$\frac{225}{2252} = \frac{14641 S^2}{0.09 + 0.64 S^2}$$

$$\therefore \boxed{S = 0.03} \text{ is } \dots \dots \underline{2M}$$

$$\text{Now } N_s = \frac{120 f}{P} = \frac{120 \times 50}{4} = 1500 \dots \dots \underline{2M.}$$

$$S = \frac{N_s - N}{N_s}$$

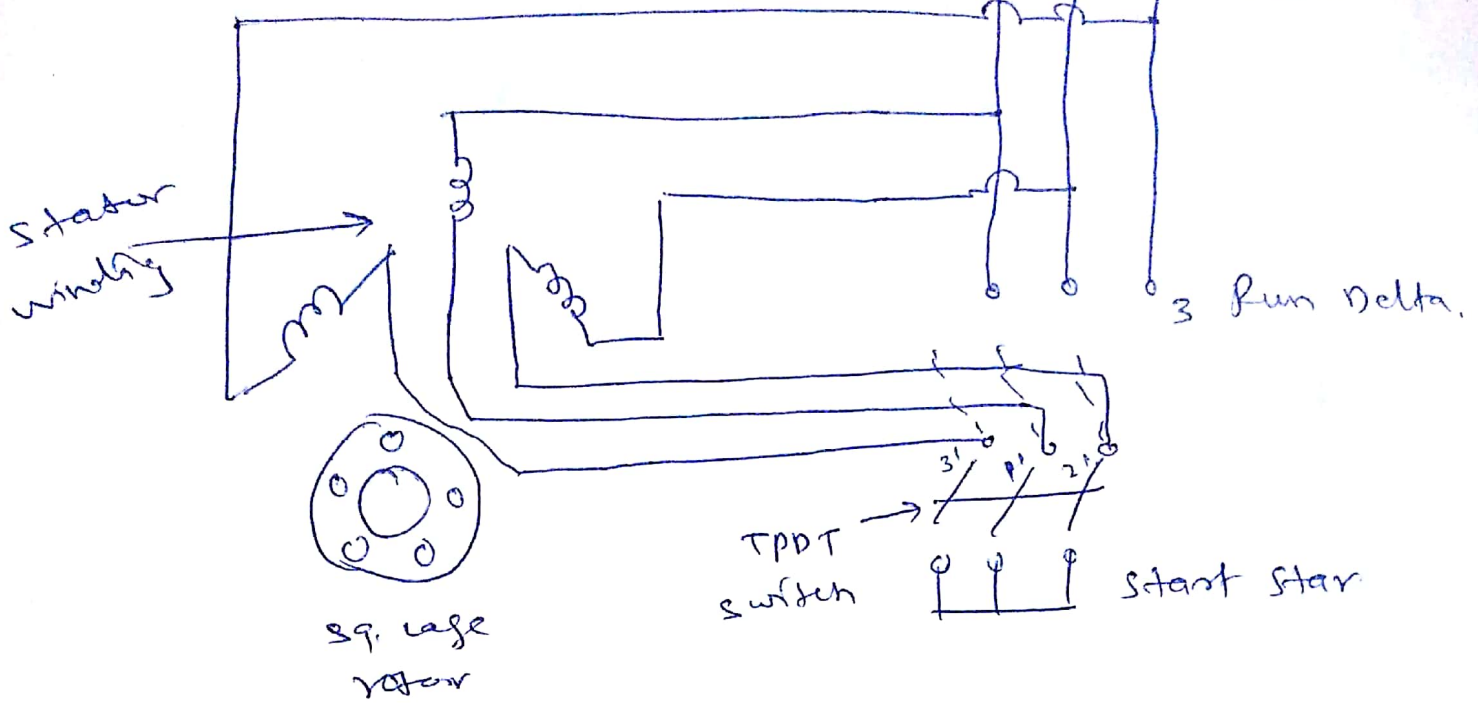
$$0.03 = \frac{1500 - N}{1500}$$

$$\therefore \boxed{N = 1455 \text{ rpm}} \dots \dots \underline{3M.}$$

Q 6

① Star delta starter.

1 2 3 3 + supply
R.P. code 25397



Star - delta starter - 03 M

Explanation - 07 M.

② Megger - Block dia - 03 M

Explanation - 07 M

③ A D C - Block dia. of any one ADC - 03
working - 07 M.