Harmonic: - It does with works with particular perviodic works. It is generally Employed in music approaching, Elektronic power transmission, bodie technology.

distortion: - This refers to distorbence in waves

As we know it is applied to reprating works or signals, Such as sin, Cosine works. A horizonaire of such a work is a wave with the freq that is the integral multiple of frequency of the original work, known as fundamental frequency is the original work is the first horizonic, the following horizoness are higher horizonic.

Hao this hommonics Polated to (Slettical power)

Hormonic Nothages & Current is an Ele power system are a secount of non-linear ele loads. Harmonic froq in the power gold are a freq. Cause of power quotity produces. Harmonic in power system result in increased heating in the equipment and conductors, misting in worder speed drives, and torque pulsation in motors. Reduction of harmonic is considered clasicable.

$$Pac = V. I$$

$$= \frac{Im Vm}{2}$$

$$Pac = \frac{Im^{2}R_{2}}{2}$$

NE ish

Im = Poak value of the olp current

$$= \frac{Ipp}{2} = \frac{Imax - Imin}{2}$$

$$Imax - Imin$$

Hence ofp power earth hormour dictorium

$$(Pac)p > \frac{1}{2}B_1^2R_1 + \frac{1}{3}B_2^2R_1 + \cdots + \frac{1}{2}B_n^2P_1$$

$$= \frac{1}{2}B_1^2R_2 \left[1 + \frac{B_2^2}{B_1^2} + \frac{B_2^2}{B_1^2} + \cdots + \frac{3n^2}{B_1^2}\right]$$

$$(Pac)_0 = Pac \left[ 1 + D_2^2 + D_3^2 + \cdots D_n^2 \right]$$

$$D^2 = D_2^2 + D_3^2 + 0 ... + D_{n^2}$$

If the total harmonic distation D = 0.15

$$(Rac)_{10} = Rac [1 + (0.15)^{2}]$$
  
= 1.0225 Rac

so that is 2.25 % increase in the power given to the load.

```
are the Amp of the fundamental , second
    8, , B2, B3 and B4
32d & ath hosemanic Components.
                                                    Coso = 1
                                                                 0
                                                    Cas 30 = 13/2
                                                                 7/6
 At 5 instants
                                                    Cas 45 = 1/2
                                                    Cas 60" = 1/2
                                                                 TY
     At point 1 cot = 0 ic = I max
                                                    Cos 90 = 0
                                                    Cos 120 = -1/2
              Irrax = Ico + Bo + B, +B, +B, +B, +B, +B, -6 COS 135 = -1
                                                    cos 150 c - 3/2
     All point 2 cot = 7/3 ic = Ix
                                                    GOS (80 = -)
                                                    Cos 37/2 = 270 = 0
      ic = Icq+B+B, Cos 7/31+B, Gos 27 + B3 Cos 87 + B4 Cos 47
      IY2 = Ico + Bo + 0.5 B, + - 0.5 B2 + - B3 - 0.5 B4 - F
     At point 3 cot = 1/2, ic = ica
     ic = Ica + 20 + B, Cos 17 + B, Cos 27 + B, Cos 37 + Ba Cos 47
      Ica = Ica + Bo - B2 + B4 -> (8)
    At point a cot = \frac{27}{3} ic = \frac{7}{2}-\frac{1}{2}
              I'y = ICG + Bo - 0.5B, -0.5B2 + B3 - 0.5B4 -> 9
     At point 4 cot = T , le = -min
       ic = Ica + Bo + B, COST + B, COS 217 + B, COS 217 + B, COS 477
     Im = Ico+ Bo -B, + B2 -B3 + Bq - 10
  Solving (5) Eq. we get Bo, B, , B2, B3, B4 We get.
   Incix + Imin = Ica + Bo + B, + B2 + B4 + B4
               = Icg + Bo - B, +B2 - B3+B4
   Smar + I min = 2ICQ + 2B0 + 2B2 + 2B4 -> 11
    2142 = 27c0 +280 +8/1 -B2-28/2-B4
   2 T-1/2 = 27c0 + 280 - 8, - 82 + 288 - 84
```

```
Adding Eq (1) E (1) to tind Bo
Imax + I min + 2I/2 + 2I-1/2 = 6 Ica + 6 Bo
                             = 6 [ Icq+B0]
                             = 6 Bo
        ·; Bo= 6 [ Imax + Imin + 2] 1/2 # 2]-1/2)
      Imar - Imin = 28, +283
      2 1-1/2 - 2IV2 = -2B, + 4B3
        Imax - Imin + 2I - 1/2 - 2I 1/2 = 28/1+2B3 - 28/1+ AB3
              3 \cdot 8_3 = \frac{1}{6} \left[ \frac{1}{1} \max - \frac{1}{1} \min \left( \frac{1}{2} - \frac{1}{1} - \frac{1}{2} - \frac{1}{2} \right) \right]
        Sirally
                 Bo = 6 [ Irrat +2 I'/2 +2 I-1/2 + Imin]
                 B1 = 3[ Imax + I' = I - 1/2 - Imin]
                 B2 = 4 ] Irrax - 2 Icg + Imin]
                 Be = 6 [I max -2 I /2 + 2 I - 1/2 - I max]
                   Ba = 12 [ Irrax - 4 I 1/2 + 6 ICQ - 4 I - 1/2 + Imin]
          Hore the harmonic distortion co-Efficient can be
           obtained
                         .Dn = 13,1
```

By = Imax + Imin - 2 JCQ As the Amp of the fundamental & 2nd hormonic are wo, the 2nd harmonic distortion can be call as 1. D2 = 1B2/ x100 the method was those point on the collector whent were form to obtain the amplitude of the hormonis his is called 3- part method of determing and homoric disks en order harmonic distortion (five point method As the non-linearity present in dynamic character brease, the order of the hormone distortion also inchases let the mathematical expression for the Collector wrecht alle to higher ander harmone be ic = 4,16 + 42 16 + 43 18 + 44 16 -20 solo ilp signal ib = Ibm Coscot except. ic = K, Ibm Cescot + K2 - bm Costcot + K3-Ibm Costcot + Aq Ibm Costcot -> 2 Sub content, condect, a confect and Edoing trigometers open, ext. (3) ic = Bo+B, Coscot + The Ibm 1+ Cosecot ic = Both Coscot + B2 Cos2cot + B3 Cos3cot + B4 Cos4col -> The total current at Collector including de bias can be wirthen as ic = icp + 30 + B, Coxet + B2 Cossect + B3 Cossect + B4 Cossect where Ico+Bo is the de component

The de current increases practically the presence of harmonies, the de current increases practically the presence of harmonic can be detected by Connecting millimeter in the Collector circuit. The leadings can be observed cutthout an a.c. input signal and with ac input signal. If the two readings care almost same there are no harmonic present but if milliammeter shown an increase in current, when an input is applied, then the harmonics can be Concluded to present in the olp signal.

Now to find the value of total Collector current at the various instant 1,283

At point 2  $\cot = \sqrt{2}$   $d = \sqrt{2}$   $d = \sqrt{2}$  At point 3  $\cot = \pi$ 

cot = T/2 , ic = -cq

col = Tile = Imin

Hence the Eq.
from Eq. (3) Bo = B2

Now Inox - Imin = - 569+ 30+ B, +3/2 - 360 - 80+ B, - B/2

 $I_{max} - I_{imin} = 28$ 

B, = Imax - Imin

Imar + Imin = - Tca + Bo+ B, + B2 + Ica + B0 - B, + B2

= 2 $^{1}$ C $_{0}$  + 2 $^{1}$ B $_{0}$  + 2 $^{1}$ B $_{2}$ 

Imax + Imin = 2 Ica + 4B2

By = Imax + Imin = 2100

As the Amp of the fundamental & 2nd hormonic and known, the 2nd hormonic distortion can be call as

 $1. D_2 = \frac{|B_2|}{|B_1|} \times 100$ 

As the method was those point on the collector current wave form to obtain the amplitude of the homoney. This is called 3- pant method of determing and homonic distor

Highen order hormonic distortion (fix point method

As the non-linearity present in dynamic character increase, the order of the hearmone distortion also increases

Let the mathematical expression for the Collection Current also to higher order harmonic be

ic = 4,16 + 42 16 + 43 18 + 44 16 -20

sob ilp signal ib = Ibm Coscot expd.

ic = K, Ibm Coscot + K2 - bm Coscot + K3 - bm Coscot + K4 - bm Costut -> (2)

SUD contect, contect, & confect & doing trigometers open, ext.

ic = Bo+B, Coscot + #2 Ibm 1+ Cos2cot

ic = Both Coscot + B2 Cos200t + B3 Cos200t + Ba Cos4001 -> 4.

The total current at Collector including of bias can be writen

ic = icp + 30 + 3, Coxet + B2 Cos2cot + B3 Cos3cot + B4 Cos4cot
L) (5)

whore Ico+Bo is the de component

```
8, B2, B3 and B4 are the Amp of the turboned , second
33rd E ath harmonic Components.
                                                   6000 = r
                                                    Cas 30° = 13/2
 At 5 instants
                                                    COS 45 = 1/2
                                                    Cas 60° = 1/2
                                                                 TY
     Al point 1 cot = 0 ic = I max
                                                    Cos 90 = 0
                                                    Cas 120 = -1/2
              Irrax = Ico + Bo + B, +B, +B, +B3+Ba - 6 COS 135 = - 13
     All point 2 not = Ty ic = Iy
                                                    cos 150 e - 3/2
                                                    Cos (80 = -)
                                                    Cos 37/2 = 270 = 0
      ic = ICQ+B0+B, Cas T/3+B, Cas 23+B3 cas 87+B4 cos 47
     IV2 = Icg + Bo + 0.5B, + - 0.5 B2 + - B3 - 0.5B4 - (7)
     At point 3 cot = 1/2, iz = ica
    ic = Ica+ 20 + B, Cos = + B, Cos = 27 + B, Cos 37 + Ba Cos ATY
     Ica = Ica + Bo - B2 + B4 -> (8)
   At point a cot = \frac{27}{3} ic = \overline{1}-\frac{1}{2}
             Ing = ICQ + Bo - 0.5B, -0.5B2 + B3 -0.5B4 -> 9
    At point 4 cot = T , ic = Tmin
      ic = Ica + 30 + B, COST + 3, COS 217 + B, COS 217 + B, COS 477
    Tmin = Ico+ Bo - B, + B2 - B3 + B4 - 10
Solving (5) Eq. we get Bo, B, , B2, B3, B4 We get.
 I max + I min = Ica + 80 + 8/4 + 82 + 3/4 + B4
            = Icg + Bo - B, + B2 - B3 + B4
 Smoot + I min = 27 CQ + 280 + 282 + 284 = >
  2142 = 27c0 +280 +B/1 -B2 -28/3 - B4
  2 I-1/2 = 2 Ico + 2Bo - 8, - B, + 2B3 - B4
```

23/2+21-1/2 = 4IC@ + 4B0 - 2B2 - 2Bq -> 12

0

Adding Eq (1) & (1) I'md Bo Imax + I min + 25/2 + 25-4 = 6 Ica + 6 Bo = 6 [ Icg+Bo] = 6 Bo ·; Bo= 1 [mar + Imin + 25 1/2 # 2]-1/2] Imax - Imin = 28, +283 2 I-1/2 - 2Ir2 = -2B, + AB3 Imax - Imin + 2I -1/2 - 2I 1/2 = 28/1+283 - 28/1+483 6B3 :. B3 = 1 [ Imax - Imin + 2 I - 1/2 - 2 I /2] Pirally Bo = 6 [ I man +2 I / + 2 I / + I min] B, = 3 [ Imax + I & - I - 1/2 - Imin] 82 = 4 ] Irrax - 2 Icg + Imin] Bo = 6 [I max -2I/2 +2I-1/2 - Imax] Ba = 12 ] Irrox - 4 I 1/2 + 6 Icq - 4 I - 1/2 + Imin] flore the hormanic distortion co-Efficient can be Obtained by -Dn = 13n1

Power of duc to distortion

$$Pac = V. I$$

$$= \frac{Im Vm}{2}$$

$$Pac = \frac{Im^2 R_2}{2}$$

Im = Poak value of the olp current

$$= \frac{Ipp}{2} = \frac{Imax - Imin}{2}$$

$$B_1 = \frac{Imax - Imin}{2}$$

Hence ofp power with hormour distortion

$$(Pac)p = \frac{1}{2}B_1^2R_L + \frac{1}{8}B_2^2R_L + \frac{1}{2}B_0^2R_L$$

$$= \frac{1}{2}B_1^2R_L + \frac{1}{8}B_1^2 + \frac{1}{8}B_2^2 + \frac{30^2}{8^2}$$

$$(Pac)_0 = Pac \left[ 1 + D_2^2 + D_3^2 + ... D_n^2 \right]$$

$$D^2 : D_2^2 + D_3^2 + 0 ... + D_{n^2}$$

If the total harmonic distation D = 0.15

$$(Pac)_{10} = Pac [1 + (0.15)^{2}]$$
  
= 1.0225 Pac

so that is 2.25 % increase in the power given to the load.

## Transformer Coupled class A Amplifier:

\* For maximum power transfer to the load, the impedence matching is necessary.

\* For loads like boud speaker, having low impedence values, impedence matching is difficult using directly coupled amplifies circuit.

\* This is because land speaker resistance is in the range of 3 to 4 ohms to 16 ohms while the output impedence of series fed directly coupled class A amplifier is very much high.

It this problem can be eliminated by using transformer to deliver power to the load. The transformer is called an output transformer and amplifier is called transformed coupled class A amplifier.

Properties of trianstomer!

\* Consider a transformer as shown in the fig. which is connected to a load Tresistance R.

\* while analysing transformer, is is assumed that the transformer is ideal and there are no loses in transformer. Similarly the winding

Resistances are assumed to be Zero.

NI= Number of turns on primary
N2= Number of turns on secondary
Vi= Voltage applied to primary
V22 Voltage on secondary

## Iz= pormary Current.

1) Troms nation

The ratio of no. of turns on secondary to the no. of turns on primary is called turns ratio and is denoted by n.

\* Sometimes it is specified as  $\frac{N_2}{N_1}:1$  (on  $\frac{N_1}{N_2}:1$ 

2) voltage transformation!

The transformer transforms the voltage applied on or to other side proportional to turns ratio. The transformer be step up an step down transformer.

$$\frac{V_2}{V_1} = \frac{N_2}{N_1} = n$$

In amplifier analysis, load impedence is going to be smo And the transformer is to be used for impedence matchin Hence it has to be a step down transformer.

3) Current transformation L

The Current in the Schondary winding is diversely proportional to the number of turns of windings.

$$\frac{\overline{I_2}}{\overline{I_1}} = \frac{N_1}{N_2} = \frac{1}{n}$$

Mumber of Thank on Seconda

integ at bylogic sports

4) Impedence transformation!

As current and voltage get transformed from primary to Secondary, an impedence Seen from Either side also changes. The impedence of the load on secondary is Re.

$$R_{L} = \frac{V_{2}}{T_{2}} \quad \text{and} \quad R_{L} = \frac{V_{1}}{T_{1}}$$

$$V_{1} = \frac{N_{1}}{N_{2}} \quad V_{2} \quad \text{and} \quad \frac{C_{1}}{T_{2}} = \frac{N_{2}}{N_{1}} \quad C_{1} = \frac{N_{2}}{N_{1}} \quad C_{2}$$

$$R_{L} = \frac{N_{1}}{N_{2}} \quad V_{2} \quad \frac{N_{1}}{N_{2}} \quad V_{2} \quad \frac{N_{1}}{N_{2}} \quad X = \frac{N_{1$$

The Re is reflected impedence.

Problem

The load of 452 is Connected to the Secondary of a transform having primary turn of 200 and secondary turns of 20. Calculate the Sieflected load impedence on Primary.

solution Given that

$$R_{L} = 4.5L$$
  $N_{1} = 200$   $N_{L} = 20$ 

$$N_{1} = \frac{NL}{N_{1}} = \frac{20}{200} = 0.1$$