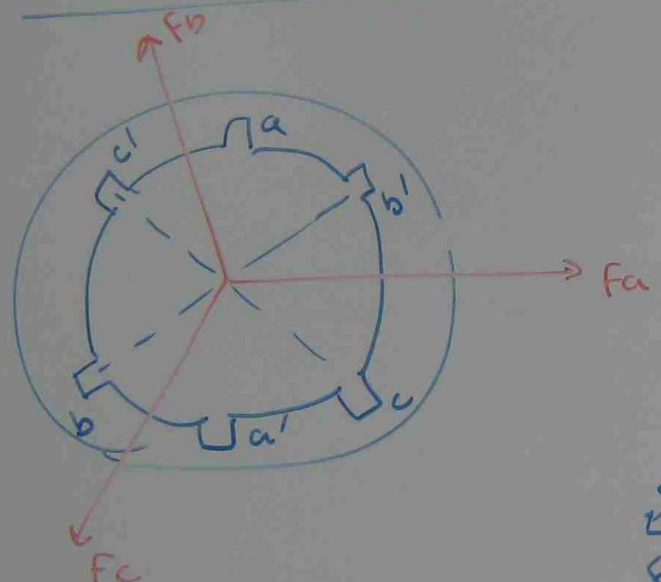
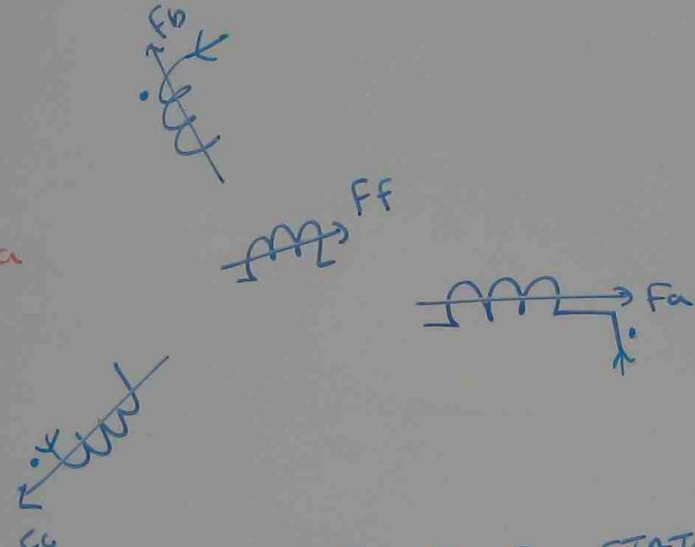
AC MACHINE — G043, G045

ROTATING FIELD DUE TO 3φ WINDING





F_a, F_b, F_c – STATOR FIELD DIRECTION

F_f = ROTOR FIELD DIRECTION

I_m = MAXIMUM CURRENT

N = NUMBER OF TURNS

$$i_a = I_m \cos \omega t = \frac{I_m}{2}\left(e^{j\omega t} + e^{-j\omega t}\right)$$

$\omega = 2\pi f$

$\pi = 3.1416$

f = FREQUENCY (HZ)

$$i_b = \frac{I_m}{2}\left(e^{j(\omega t - 2\frac{\pi}{3})} + e^{-j(\omega t - 2\pi/3)}\right)$$

$$i_c = \frac{I_m}{2}\left(e^{j(\omega t + 2\pi/3)} + e^{-j(\omega t + 2\pi/3)}\right)$$

$$a = \frac{I_m N}{2}\left(e^{j\omega t} + e^{-j\omega t}\right) \times e^{j0}$$

$$f_b = \frac{I_m N}{2}\left(e^{j\omega t} + e^{-j(\omega t - 4\pi/3)}\right)$$

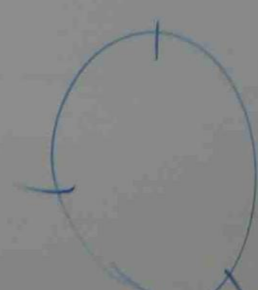
$$f_c = \frac{I_m N}{2}\left(e^{j\omega t} + e^{-j(\omega t + 4\frac{\pi}{3})}\right)$$

$$\boxed{F = \frac{3 I_m N}{2} e^{j\omega t}}$$

ROTATIONAL FORCE PRODUCES BY 3ϕ WINDING

I_m = MAXIMUM CURRENT

N = NUMBER OF TURNS



POSITION OF ROTOR	I_a	I_b	I_c
0°	I_m	$-\frac{1}{2} I_m$	$-\frac{1}{2} I_m$
30°	$\frac{\sqrt{3}}{2} I_m$	0	$-\frac{\sqrt{3}}{2} I_m$
60°	$\frac{1}{2} I_m$	$\frac{1}{2} I_m$	$- I_m$
90°	0	$\frac{\sqrt{3}}{2} I_m$	$-\frac{\sqrt{3}}{2} I_m$

CONDITION

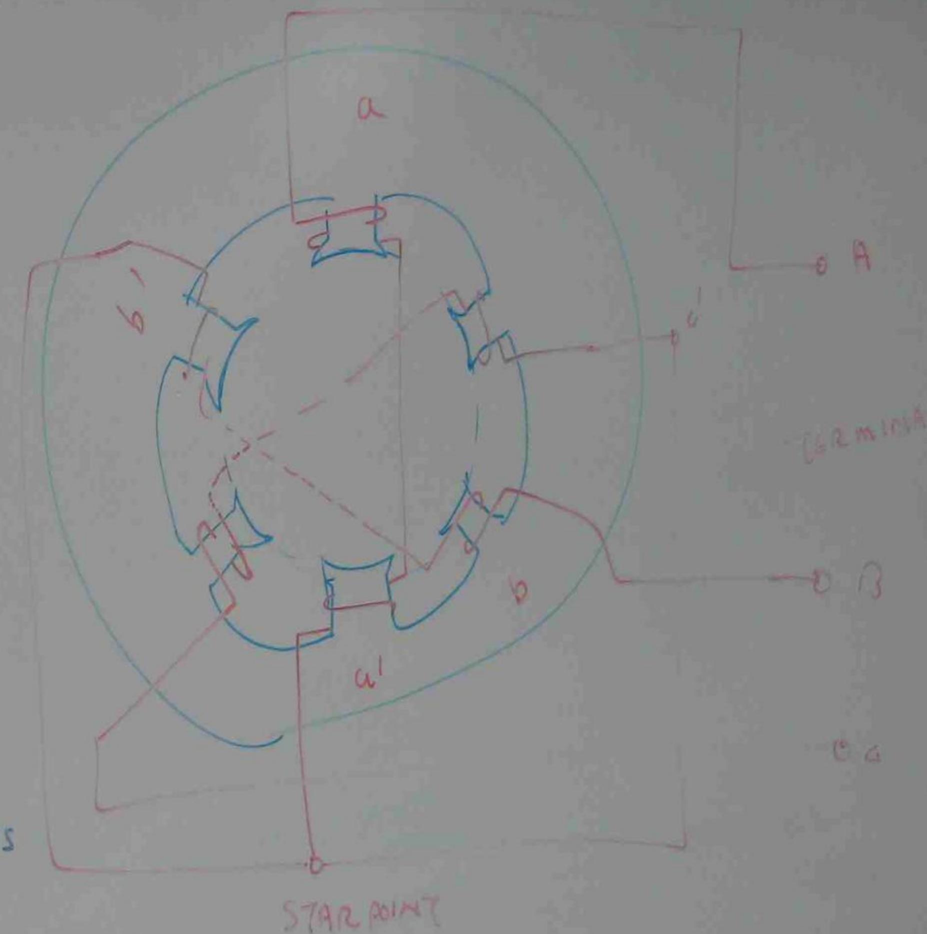
STATOR COILS ARE 120° APART

CURRENT FLOWS IN TO DOTS

THE CURRENTS IN a, b, c COILS ARE VARYING AS ABOVE TABLE

THE ROTATING MAGNETIC FIELD IS PRODUCED

$$F = \frac{3 I_m N}{2} e^{j\omega t}$$



CONNECTION OF 3ϕ MACHINE

SPEED OF AC MACHINE

$$\text{SYNCHRONOUS SPEED } N_S = \frac{120 f}{P}$$

N_S = SYNCHRONOUS SPEED

f = FREQUENCY OF SOURCE

P = NUMBER OF POLES

THE SPEED OF A ROTATING FIELD DEPENDS ON THE FREQUENCY OF THE SOURCE AND NUMBER OF POLES ON THE STATOR

PROBLEM

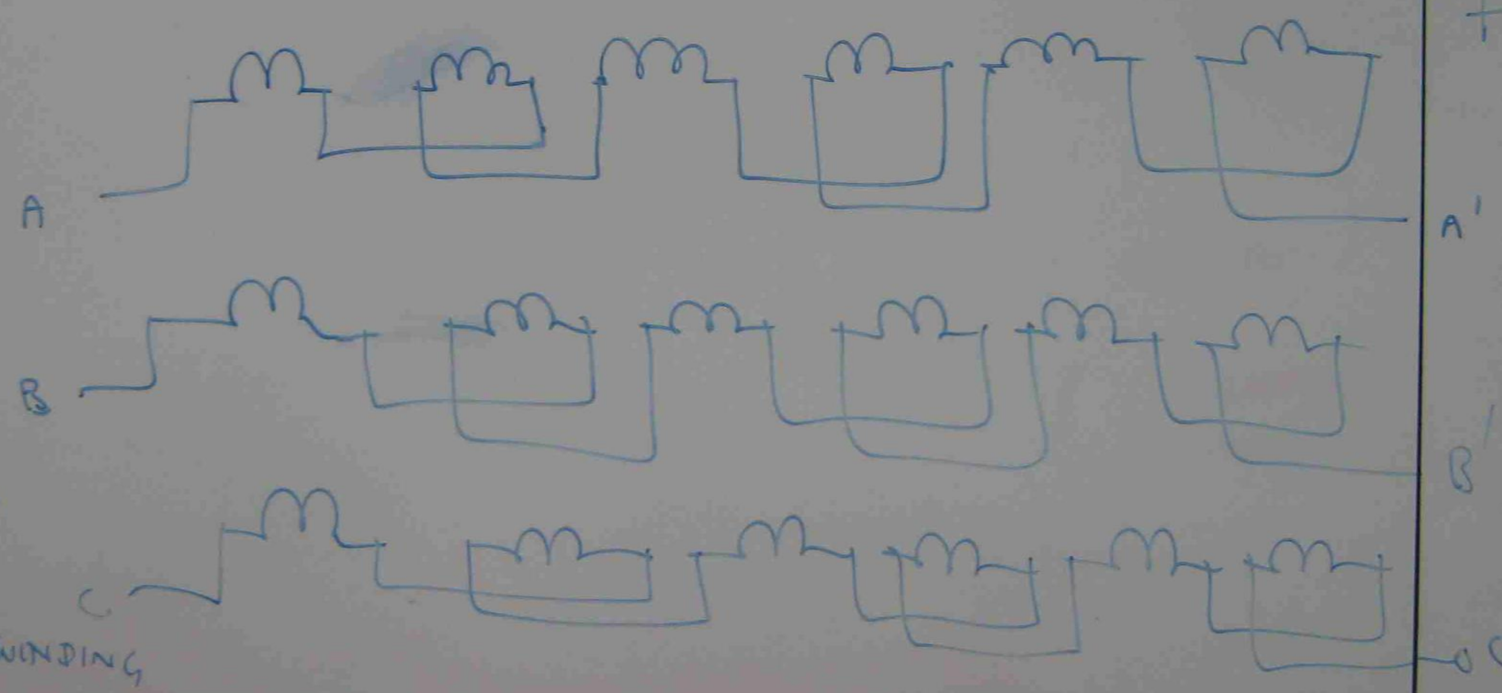
CALCULATE THE SYNCHRONOUS SPEED OF A 3ϕ INDUCTION MOTOR HAVING 20 POLES WHEN IT IS CONNECTED TO A 50 HZ SOURCE.

$$N_s = \frac{120f}{P} = \frac{120 \times 50}{20} = 300 \text{ RPM}$$

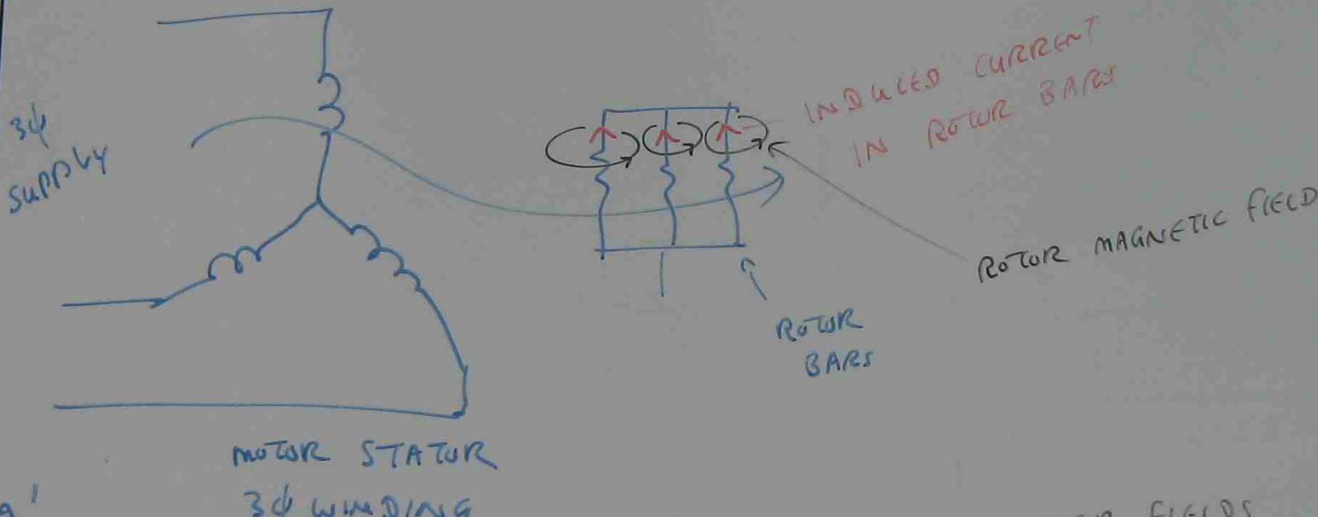
6 POLES

STATOR

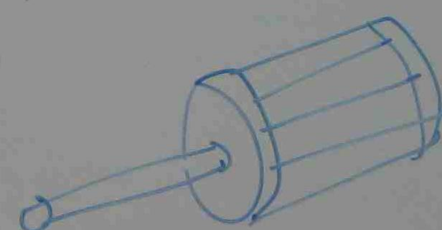
POLES FORMED BY STATOR WINDING



STARTING CHARACTERISTICS OF SQUIRREL CAGE MOTOR



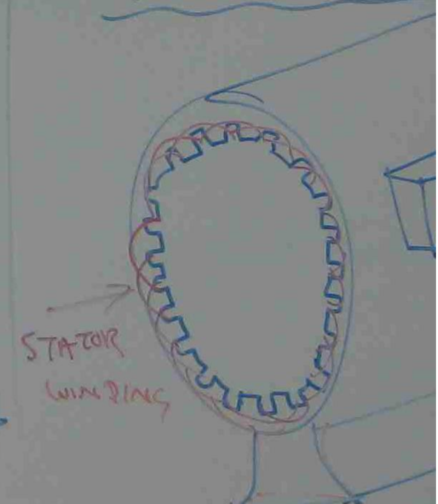
INTERACTION BETWEEN STATOR AND ROTOR FIELDS BRING THE MOTOR TO SPEED UP.



3φ WINDINGS AND

- WINDING MAY BE E
- WINDINGS ARE (
- THE COILS MAY BE

SQUIRREL CAGE INDUCTION MOTO



IRREL CAGE MOTOR

CURRENT
OR BARS

ROTOR MAGNETIC FIELD

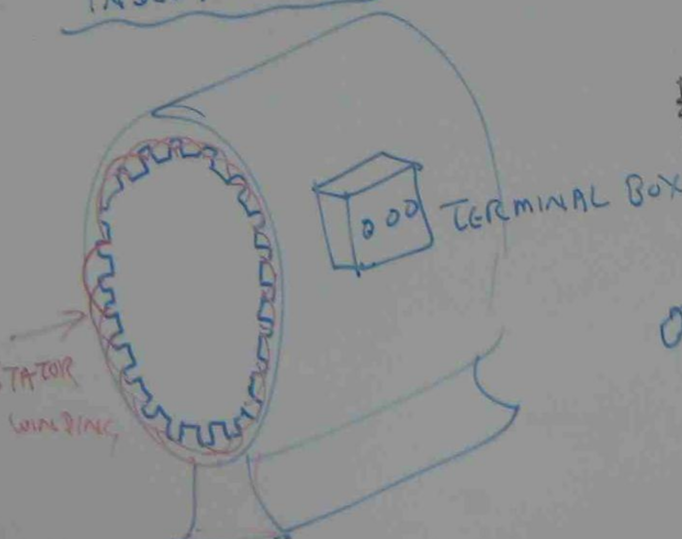
AND ROTOR FIELDS

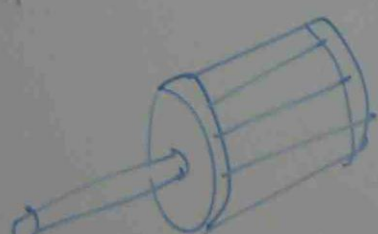
UP.

3ϕ WINDINGS AND FIELD

- WINDING MAY BE EITHER ON THE STATOR (OR) ON THE ROTOR
- WINDINGS ARE 120° ELECTRICAL DEGREE APART.
- THE COILS MAY BE CONNECTED IN STAR OR DELTA

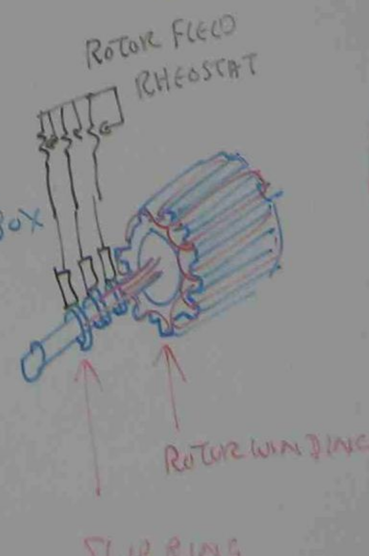
SQUIRREL CAGE INDUCTION MOTOR



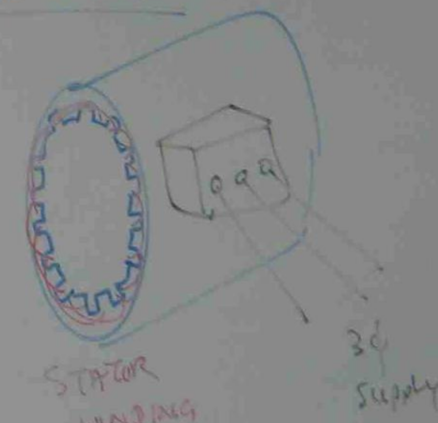


SQUIRREL CAGE
ROTOR

WOUND ROTOR MOTOR

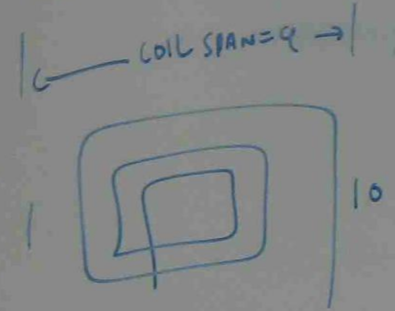


WOUND ROTOR



3φ MOTOR WINDING DESIGN

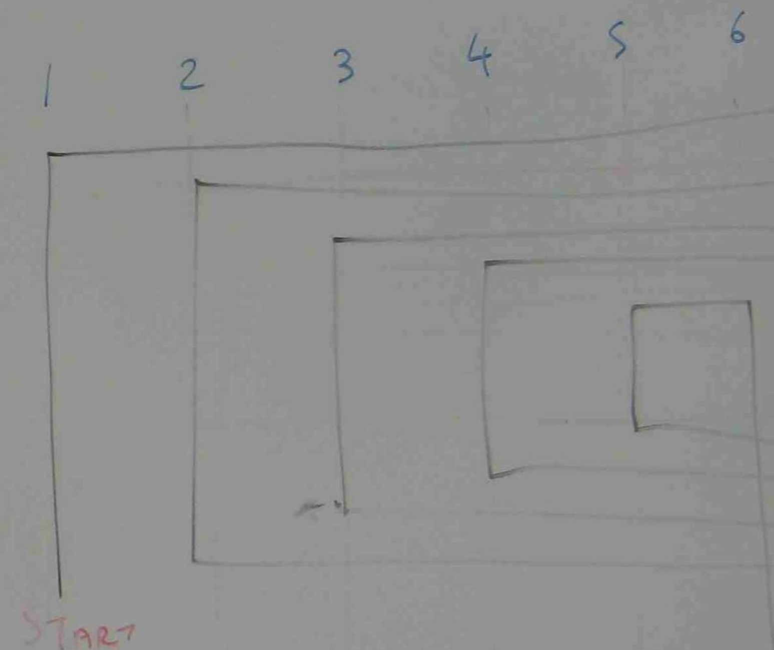
COIL SPAN



$$\text{COIL SPAN} = \frac{\text{No of SLOTS}}{\text{No of poles}} = \frac{S}{P}$$

Pb. DESIGN 3φ, 36 SLOTS, 4 poles WINDING.

$$\text{COIL SPAN} = \frac{\text{No. of SLOTS}}{\text{No. of poles}} = \frac{36}{4} = 9$$



1 → 10
2 – 9
3 – 8
4 – 7
5 – 6

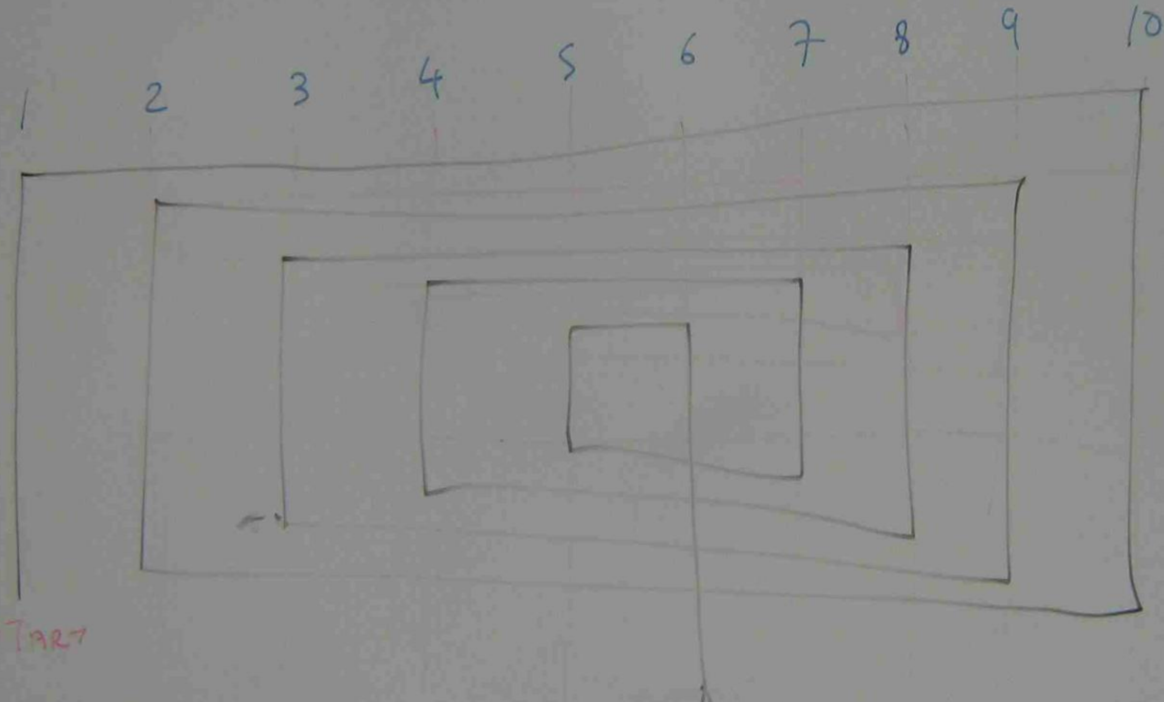
1 POLE.

CONCENTRIC

COIL SPAN = $\dfrac{\text{No. of SLOTS}}{\text{No. of POLES}} = \dfrac{36}{4} = 9$

SLOT 1 → 10

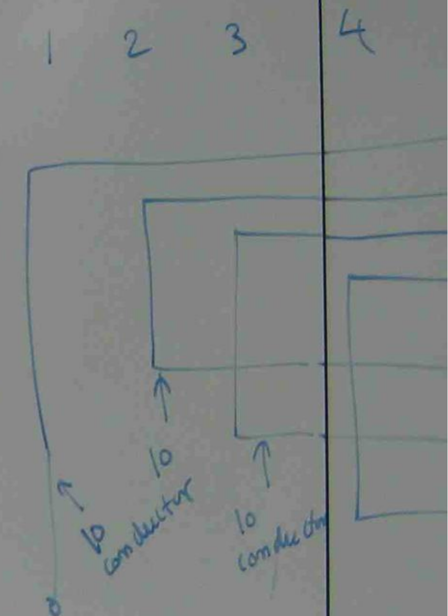
POLES



1 POLE

1 → 10
2 – 9
3 – 8
4 – 7
5 – 6

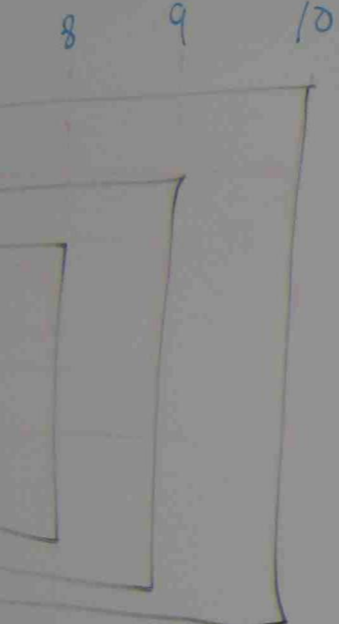
CONCENTRIC WINDING

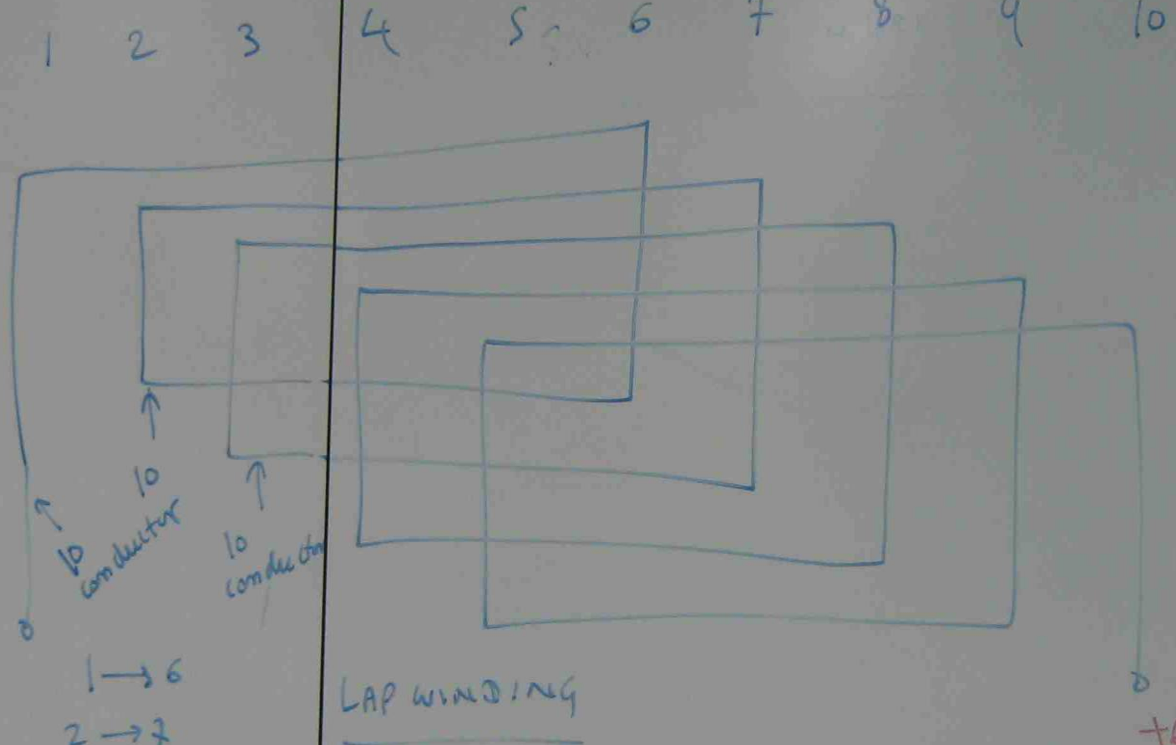


1 → 6
2 → 7
3 → 8
4 → 9
5 — 10

LAP W

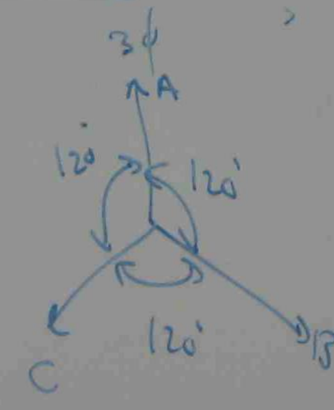
1 → 10



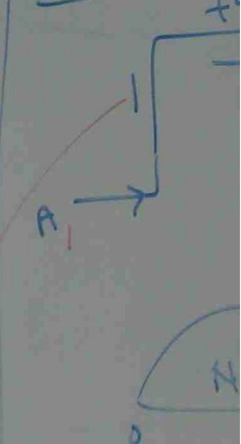


1 → 6
2 → 7
3 → 8
4 → 9
5 — 10

LAP WINDING



PHASE (A)



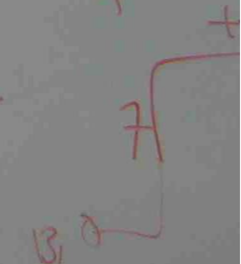
EACH POLE =

COIL SPAN

180° = 9

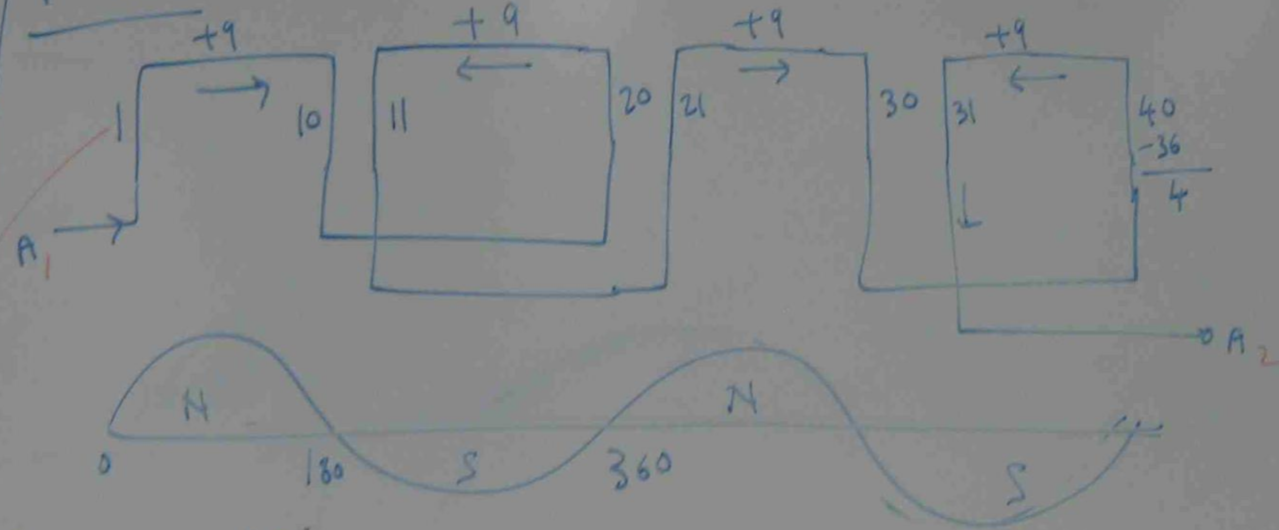
120° —

(B) PHASE



8 9 10

PHASE (A)



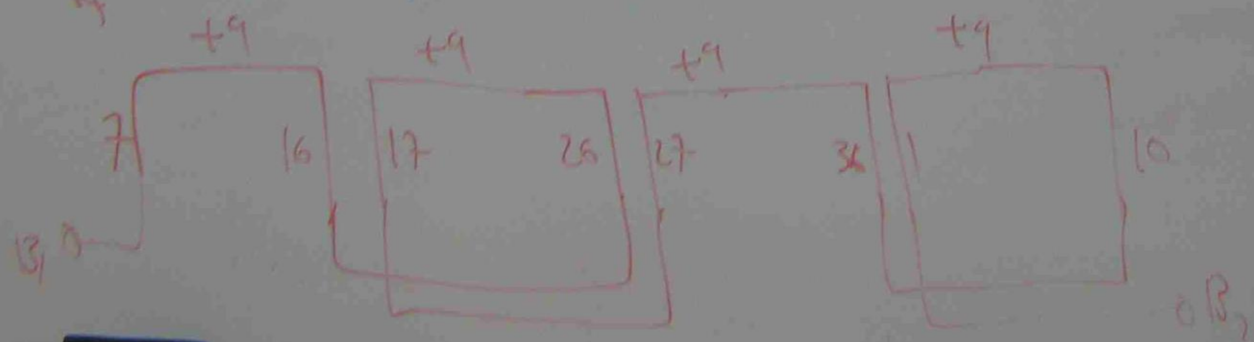
EACH POLE = 180°

COIL SPANS 9 SLOT = 180°

180° = 9 SLOTS

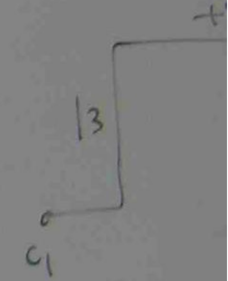
$120° \longrightarrow ? = \frac{9 \times 120}{180} = 6$ SLOTS.

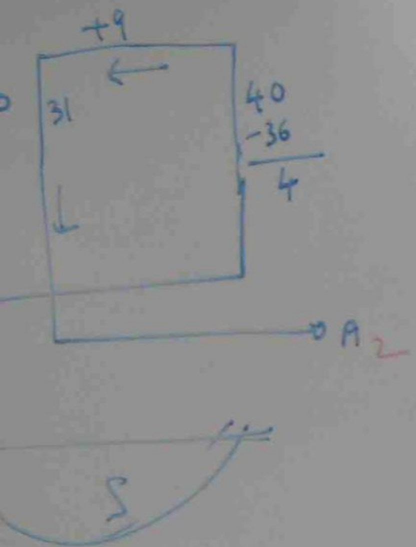
(B) PHASE



C PHASE

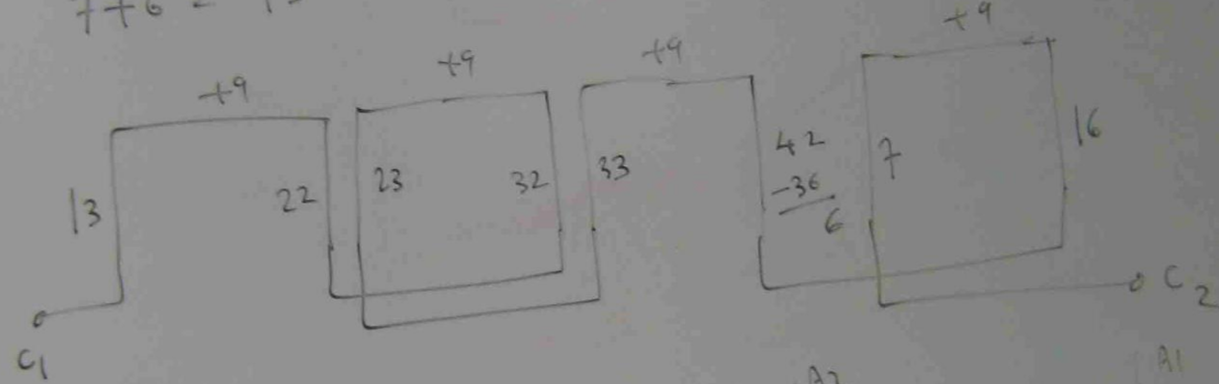
7+6 =



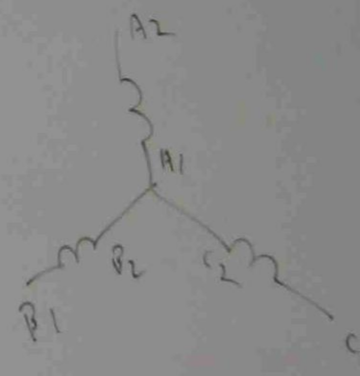

+9
31
40
-36
4
A2
5

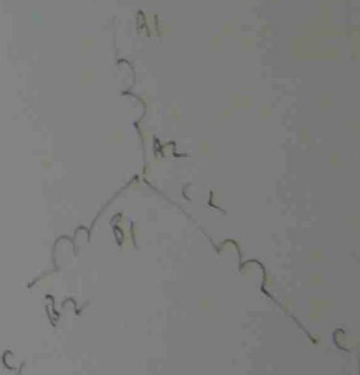
C PHASE

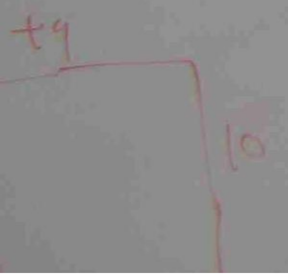
$7+6 = 13$


+9
+9
+9
+9
13
22
23
32
33
42
-36
6
7
16
C1
C2


A1
A2
C1
B2
B1
C2


A2
A1
B2
C2
B1
C1


A1
A2
C2
B1
B2
C1


+9
10