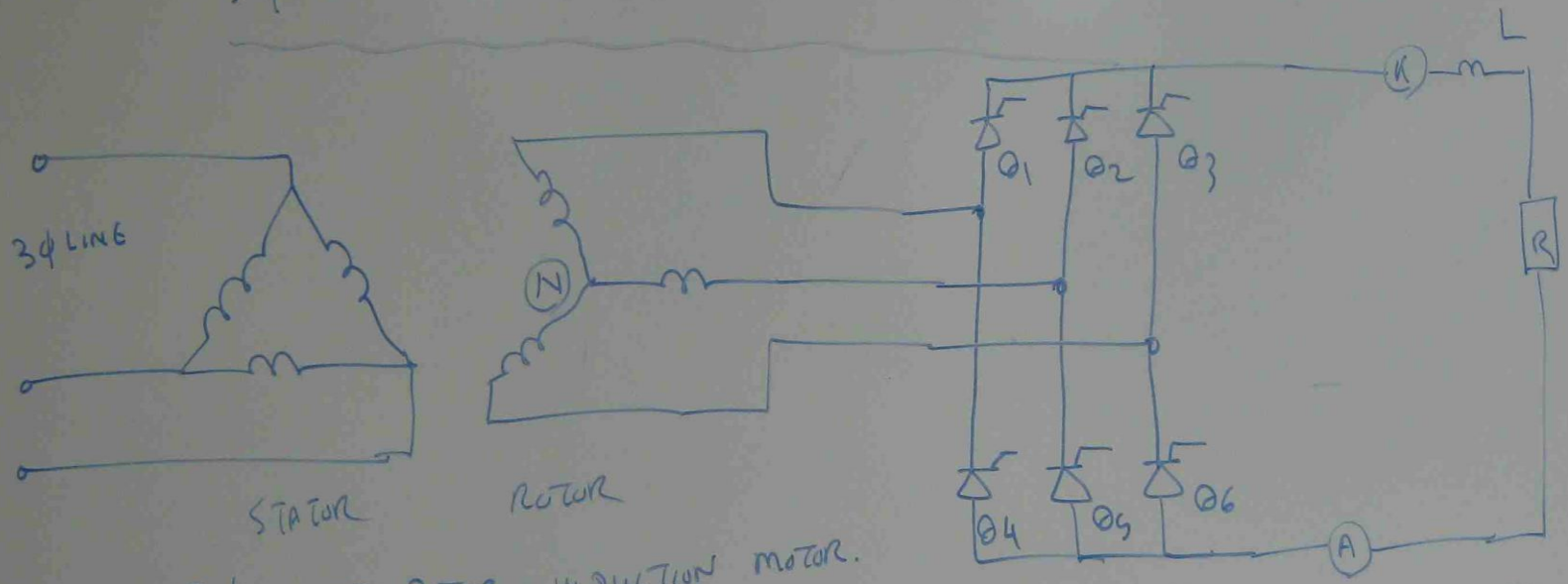
3φ SCR CONNECTION FOR VARIABLE DRIVE SYSTEM



3φ WOUND ROTOR INDUCTION MOTOR.

BY ADJUSTING THE THYRISTOR FIRING ANGLE, THE ROTOR CURRENT & FLUX CAN BE CHANGED AND MOTOR SPEED CAN BE CHANGED.

(3φ 6 PULSE CONVERTER)

$$E_d = 1.35\ E \cos\alpha$$

E_d = DC VOLTAGE PRODUCED BY 3ϕ 6 PULSE CONVERTER

E = EFFECTIVE VALUE OF AC LINE TO LINE VOLTAGE (V)

α = FIRING ANGLE

$$P_1 = 1.35\ V_{rms}\ I_D \cos\phi$$

$$S_1 = \sqrt{3}\ V_{rms} \times 0.78\ I_D$$

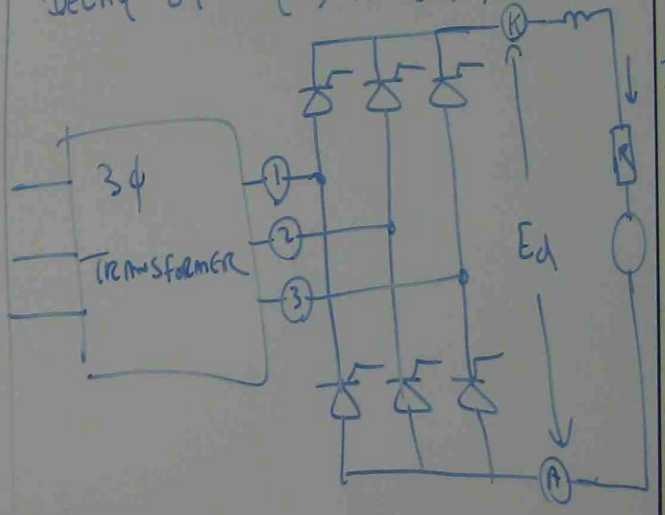
$$1.35\ V_{rms}\ I_D$$

$$I_{1\,rms} = \frac{\sqrt{3} \times \sqrt{2}\ I_D}{\pi}$$

$$= 0.78\ I_D$$

I_D = DC CURRENT.

ph THE FOLLOWING 3ϕ CONVERTER IS CONNECTED TO 3ϕ 480V 60HZ SOURCE. THE LOAD CONSISTS OF A 500V DC SOURCE HAVING AN INTERNAL RESISTANCE 2Ω. CALCULATE THE POWER SUPPLIED TO THE LOAD FOR TRIGGERING DELAY OF (a) 1s (b) 7s



$E_d = 1.35\ E \cos\alpha$

$\alpha = 15^\circ$, $E = 480$

$E_d = 1.35 \times 480 \cos 15$

$= 1.35 \times 480 \times 0.9659$

$= 625.9\ V$

$I_D = \frac{E_d}{R} = \frac{625.9}{2} = 312.95\ \text{Amp.}$

$S_1 = \sqrt{3}\ V_{rms} \times 0.78\ I_D$

$= 1.7321 \times 480 \times 0.78 \times 312.95$

$= 202447\ VA$

$= 202.947\ KVA$

$\alpha = 75^\circ$

$E_d = 1.35 \times 480 \times \cos 75$

$= 167.71\ V$

$I_D = \frac{E_d}{R} = \frac{167.71}{2} = 83.85\ \text{Amp}$

$S_1 = \sqrt{3}\ V_{rms} \times 0.78\ I_D$

$= 1.7321 \times 480 \times 0.78 \times 83.85$

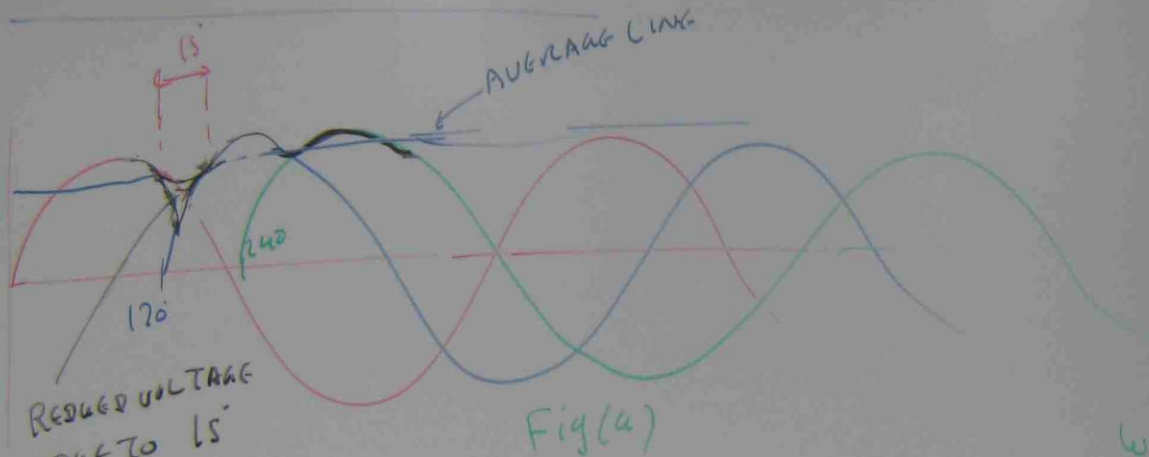
$= 54381\ VA$

$= 54.38\ KVA$

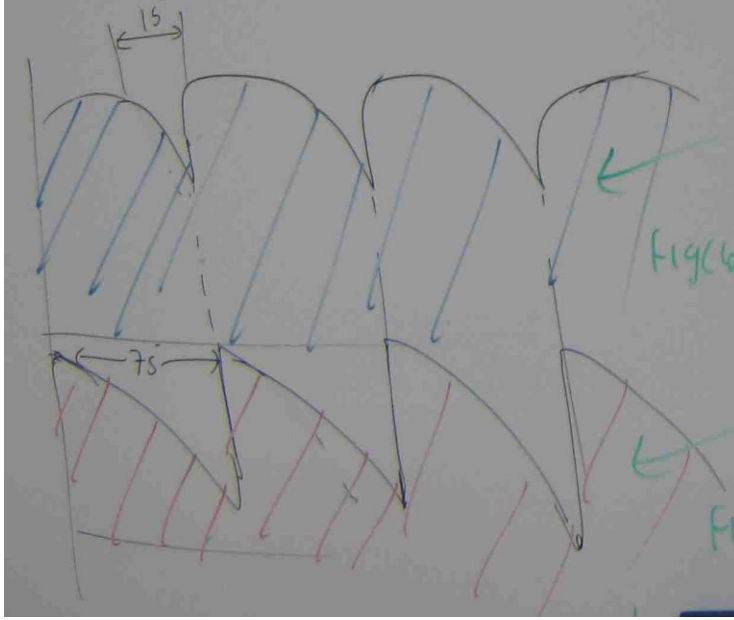
$W = \frac{2\pi T N}{60} \Rightarrow N = \frac{W \times 60}{2\pi T}$

N = SPEED, T = TORQUE, W = POWER

CONCEPTS of DELAYED FIRING ANGLE



Fig(a)



Fig(b) TOTAL POWER TRANSFER AT $\alpha = 15°$

Fig(c) α 75° TOTAL POWER TRANSFER AT

IN THE DIAGRAM, WHEN FIRING ANGLE IS ZERO, THE OUT PUT VOLTAGE IS THE VOLTAGE PRODUCED BY 3ϕ RECTIFIER BRIDGE.

WHEN FIRING ANGLE IS 15°, THE OUT PUT VOLTAGE IS IN FIG(b)

WHEN THE FIRING ANGLE IS 75°, THE OUT PUT VOLTAGE IS IN FIG(c)

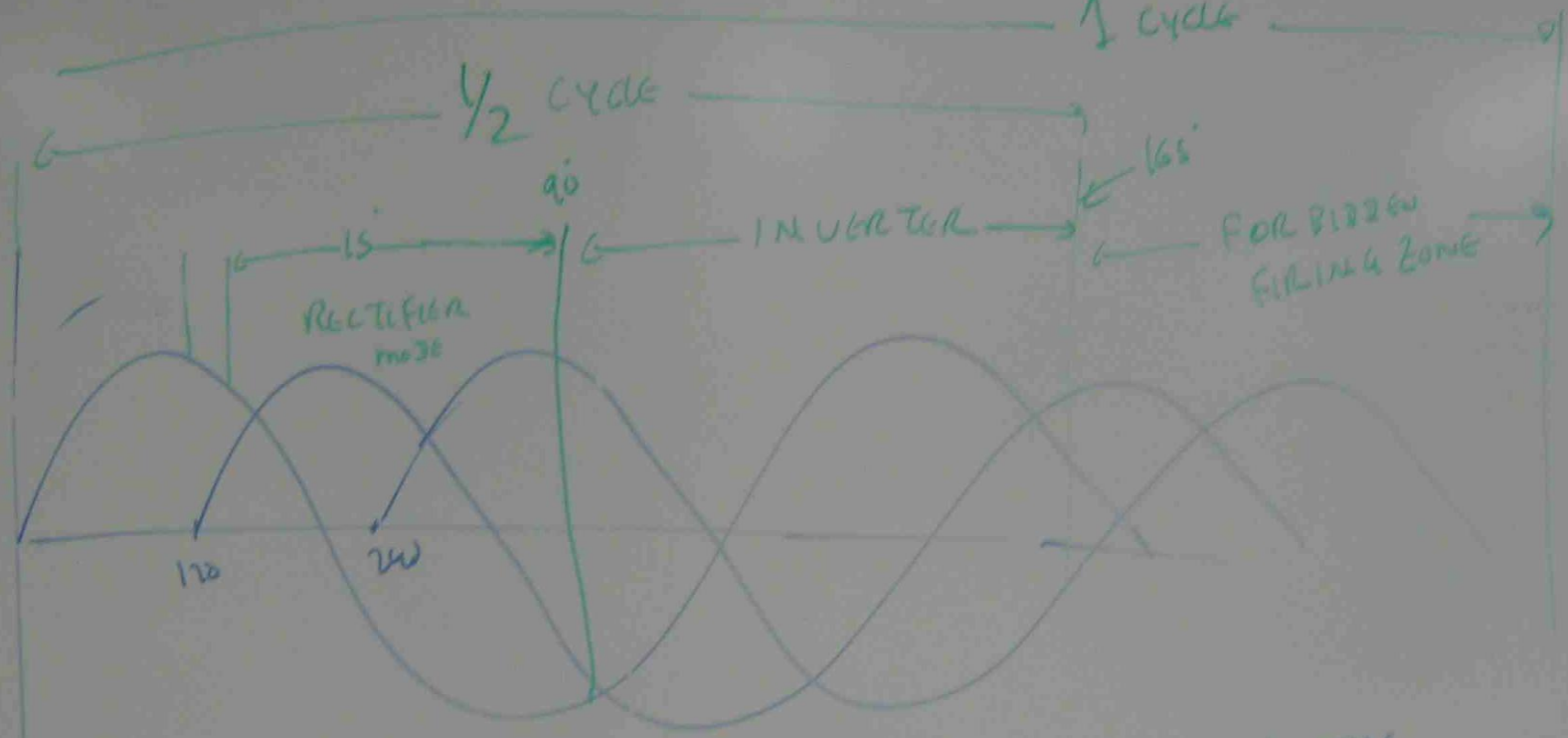
BY INCREASING THE VALUE OF FIRING ANGLE, THE OUT PUT VOLTAGE AND POWER CAN BE VARIED.

TRIGGERING MODE

DELAY TRIGGERING MODE

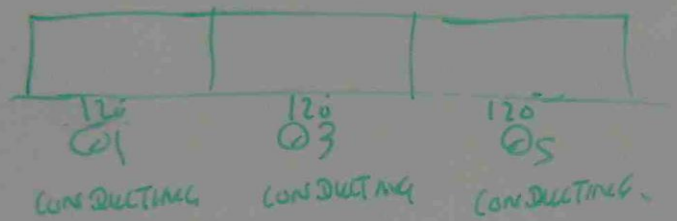
TRIGGERING RANGE $15^{\circ} \longrightarrow 165^{\circ}$

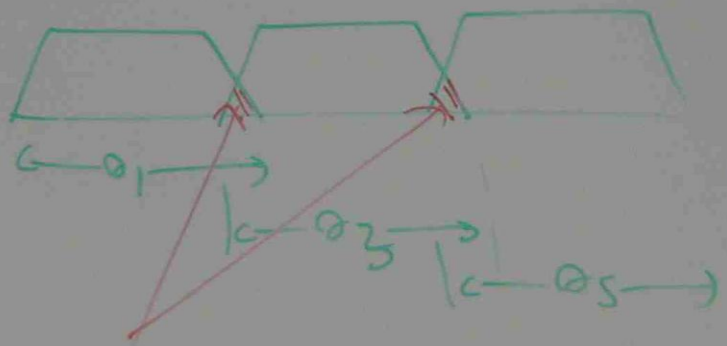
CONVERTER	$15^{\circ} \longrightarrow 90^{\circ}$
INVERTER	$90^{\circ} \longrightarrow 165^{\circ}$



IF THE TRIGGERING IS DELAYED BY MORE THAN 90°, THE VOLTAGE DEVELOPED BY CONVERTER BECOMES NEGATIVE. AND THE SYSTEM OPERATES AS INVERTER MODE CHANGING DC POWER TO AC.

COMMUTATION OVERLAP





COMMUTATING
OVERLAPPING.

EXCITINCTION ANGLE

ADVANCED ANGLE → $\beta = 180 - \alpha$

EXTINCTION ANGLE $\gamma = \beta - k$ → CONSTANT

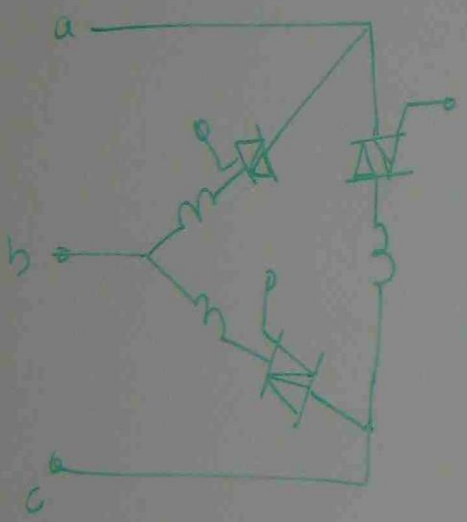
$\gamma = 15 \rightarrow 20^{\circ}$

PROPERTIES of SOME RECTIFIER CONVERTERS RESISTIVE LOAD

ITEM	CONVERTER (A)	CONVERTER (B)	CONVERTER (C)
	3φ 6 PULSE	3φ 6 PULSE + FREE WHEEL DIODE	HALF BRIDGE
FIRING ANGLE LIMIT (α)	$0 \rightarrow 90$	$60 \rightarrow 120$	$60 \rightarrow 180$
DC OUTPUT VOLTAGE	$1.35\ E \cos\alpha$	$1.35\ E(1-\cos(120-\alpha))$	$0.675\ E(1+\cos\alpha)$
DISPLACEMENT ANGLE ϕ_d	α	$30+\frac{\alpha}{2}$	$\frac{\alpha}{2}$
POWER FACTOR	$\cos\alpha$	$\cos(30+\frac{\alpha}{2})$	$\cos\frac{\alpha}{2}$
EFFECTIVE LINE CURRENT	$0.816\ I_d$	$I_d\sqrt{(120-\alpha)/180}$	$I_d\sqrt{(180-\alpha)/180}$
TOTAL APPARENT POWER	$EI\sqrt{3}$	$EI\sqrt{3}$	$EI\sqrt{3}$

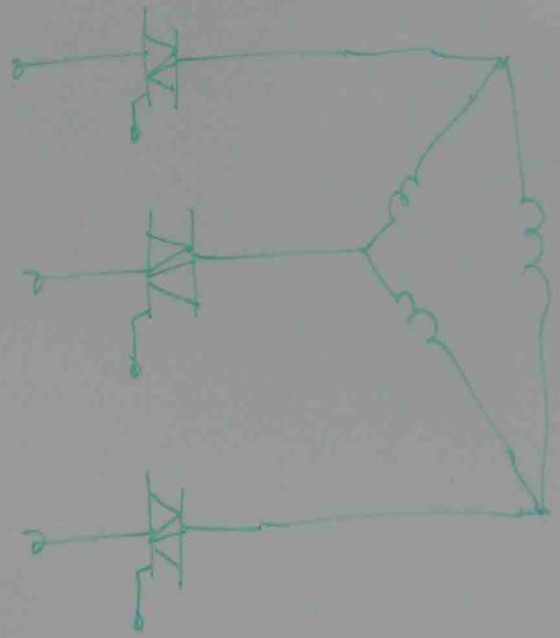
	CONVERTER (A)	CONVERTER (B)	CONVERTER (C)
ITEM	3Ph 6 PULSE	3ϕ 6 PULSE + FREE WHEEL DIODE	HALF BRIDGE
TOTAL ACTIVE POWER	$E_d I_d$	$E_d I_d$	$E_d I_d$
TOTAL REACTIVE POWER	$P \tan \phi_d$	$P \tan \phi_d$	$P \tan \phi_d$
PF (TOTAL)	P/S	P/S	P/S
PF (DISTORTION)	$\frac{P}{S} \cos \phi_d$	$\frac{P}{S} \cos \phi_d$	$\frac{P}{S} \cos \phi_d$

VARIABLE VOLTAGE – SPEED CONTROL OF SQUIRREL CAGE INDUCTION MOTOR

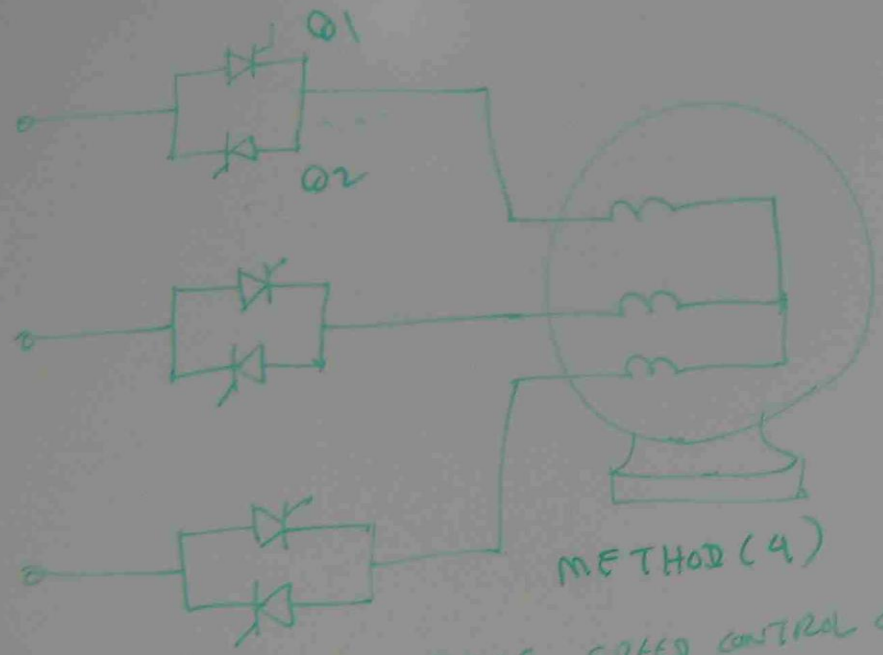


METHOD (1)

METHOD (2)

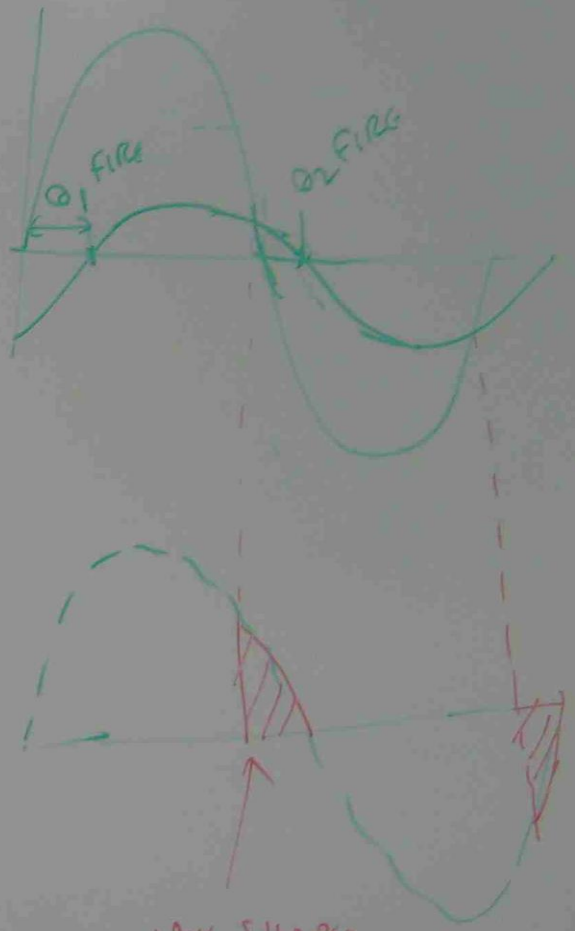


METHOD (3)

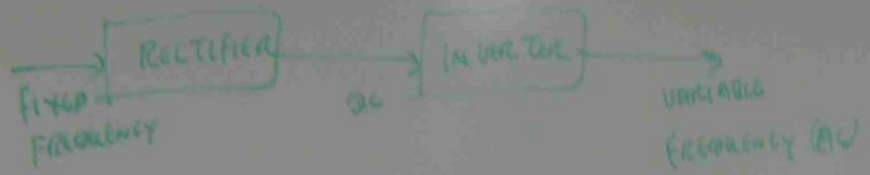


METHOD (4)

VARIABLE VOLTAGE SPEED CONTROL OF A SQUIRREL CAGE INDUCTION MOTOR.



WAVE SHAPES OF FIRED VALUE



VVI – VARIABLE VOLTAGE INVERTER

VVI TAKES INPUT POWER IN THE FORM OF ADJUSTABLE DC SOURCE.
THE SOURCE PROVIDES THE INPUT DC VOLTAGE TO PROVIDE THE
REQUIRED OUTPUT VOLTAGE AMPLITUDE

CSI – CURRENT SOURCE INVERTER

CSI TAKES INPUT POWER FOR ADJUSTABLE CURRENT SOURCE.

PWM – PULSE WIDTH MODULATED INVERTER

TAKES THE VOLTAGE FROM
FIXED VOLTAGE SOURCE. THE OUTPUT VOLTAGE WAVEFORM IS CONTROLLED BY
CHANGING WIDTH OF VOLTAGE INTERVALS.