REVIEW QUESTIONS (2)

Q 4 DESCRIBE THE MEANINGS OF THE FOLLOWING VECTOR SYMBOLS

(i) Dz0

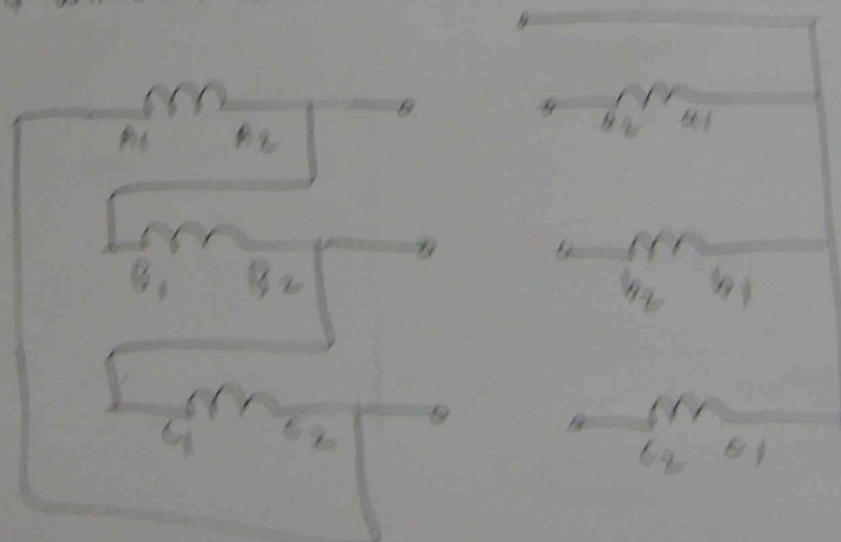
(ii) Zd6

(iii) Dy1

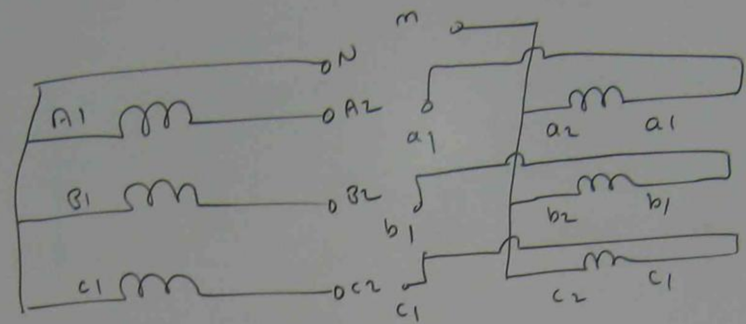
(iv) Yz11

Q 5 IDENTIFY THE VECTOR SYMBOLS AND GROUPING FOR FOLLOWING WINDING CONNECTIONS

(i)



(ii)



Q.6 LIST THE ADVANTAGES, DISADVANTAGES AND APPLICATIONS OF THE FOLLOWING WINDING CONNECTIONS

(a) DELTA – DELTA

(b) DELTA – STAR

(c) DELTA – INTER CONNECTED STAR

(d) STAR – DELTA

(e) STAR – INTERCONNECTED STAR

(f) INTERCONNECTED STAR – STAR

Q4

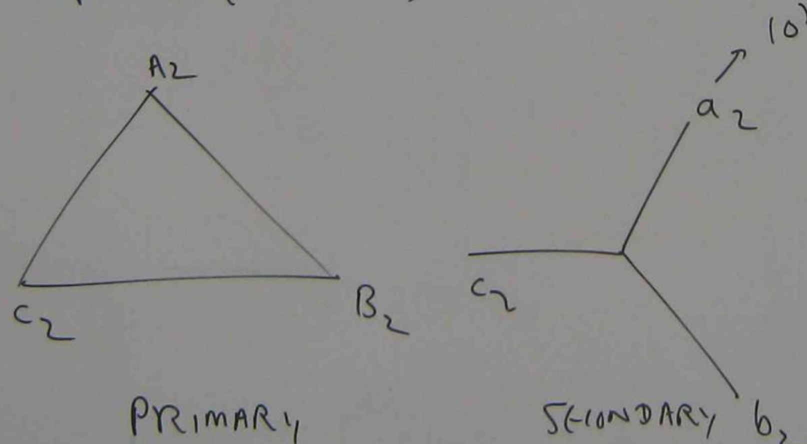
	CONNECTION	PRIMARY	SECONDARY	PHASE DISPLACEMENT POSITION	ANGLE
(i)	DZ_0	DELTA	ZIG ZAG	0 o'clock	0
(ii)	Zd_6	ZIG ZAG	DELTA	6 o'clock	180°
(iii)	Dy_1	DELTA	STAR	1 o'clock	− 30°
(iv)	Yz_{11}	STAR	ZIG ZAG	11 o'clock	+30°

Q5 (i) Dy_1

GROUP III

PRIMARY - DELTA, SECONDARY = STAR, VECTOR INDICATES 1 o'clock

PHASE DISPLACEMENT = −30°



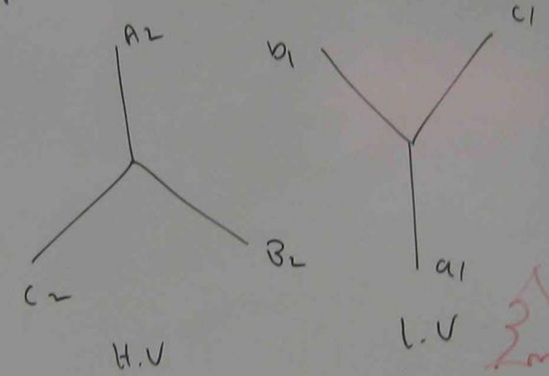
(ii) $Yy6$

PRIMARY = STAR

SECONDARY = STAR

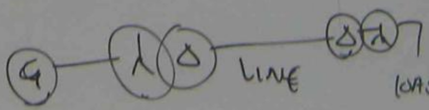
VECTOR INDICATES 6 o'clock

PHASE DISPLACEMENT = 180°



6

WINDING	ADVAN…
DELTA | DELTA	IF ON… SIDE… TWO… IN O… AT… – HIGH… TRA…
DELTA | STAR	– ELIM… HARM… – NE… – CA…
DELTA | INTERCONNECTED STAR	– E… – C…
STAR - DELTA	– –
STAR | INTERCONNECTED STAR	



⑥

WINDING	ADVANTAGE	DISADVANTAGE	APPLICATION
DELTA | DELTA  VEE	IF ONE PHASE ON EITHER SIDE IS FAULTY REMAINING TWO PHASES CAN BE OPERATED IN OPEN DELTA OR VEE AT REDUCED OUT PUT - HIGH CURRENT LOW VOLTAGE TRANSFORMER	- LOW WINDING SPACE FACTOR - COIL CONSTRUCTION DIFFICULT - HIGHER COST - HIGHER INSULATION STRESS	- VERY LITTLE APPLICATION IN POWER INDUSTRY AS FAULTY TRANSFORMER NEEDS TO BE REMOVED
DELTA | STAR 	- ELIMINATION OF THIRD HARMONIC - NEUTRAL IS AVAILABLE - CAN SUPPLY BOTH BALANCED | UNBALANCED LOAD	NO PRIMARY NEUTRAL FOR EARTHING - A FAULT ON ONE UNIT CAUSES 3φ TO BE IN OPERATIVE	STEP DOWN SUPPLY DISTRIBUTION
DELTA | INTERCONNECTED STAR	- ELIMINATE THIRD HARMONIC - CAN SUPPLY BOTH BALANCED | UNBALANCED LOADS	- NO PRIMARY NEUTRAL FOR EARTHING - A FAULT ON ONE UNIT CAUSES 3φ TO BE IN OPERATIVE	TO GIVE SUPPLY TO 3φ CONVERTERS
STAR - DELTA	- ELIMINATE THIRD HARMONIC - PRIMARY NEUTRAL FOR EARTHING	NO SECONDARY NEUTRAL - A FAULT ON 1φ CAUSES 3φ TO BE INOPERATIVE	STEP DOWN TRANSFORMER
LINE ⓐⓑ7 LOAD STAR | INTERCONNECTED STAR	- ELIMINATE 3^{rd} HARMONICS - PRIMARY NEUTRAL CAN BE EARTHED - SUITABLE FOR LARGE STEP DOWN TRANSFORMERS		STEP DOWN TRANSFORMERS

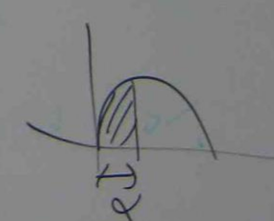
⑥

WINDING	ADVANTAGE	DISADVANTAGE
DELTA / DELTA  VEE	IF ONE PHASE ON EITHER SIDE IS FAULTY REMAINING TWO PHASES CAN BE OPERATED IN OPEN DELTA OR VEE AT REDUCED OUT PUT - HIGH CURRENT LOW VOLTAGE TRANSFORMER	- LOW WINDING SPACE FACTOR - COIL CONSTRUCTION DIFFICULT - HIGHER COST - HIGHER INSULATION STRESS
DELTA / STAR	- ELIMINATION OF THIRD HARMONIC - NEUTRAL IS AVAILABLE - CAN SUPPLY BOTH BALANCED / UNBALANCED LOAD	NO PRIMARY NEUTRAL FOR EARTHING - A FAULT ON ONE UNIT CAUSES 3ɸ TO BE IN OPERATIVE
DELTA / INTERCONNECTED STAR	- ELIMINATE THIRD HARMONIC - CAN SUPPLY BOTH BALANCED / UNBALANCED LOADS	- NO PRIMARY NEUTRAL FOR EARTHING - A FAULT ON ONE UNIT CAUSES 3ɸ TO BE IN OPERATIVE
STAR - DELTA	- ELIMINATE THIRD HARMONIC - PRIMARY NEUTRAL FOR EARTHING	NO SECONDARY NEUTRAL - A FAULT ON 1ɸ CAUSES 3ɸ TO BE INOPERATIVE

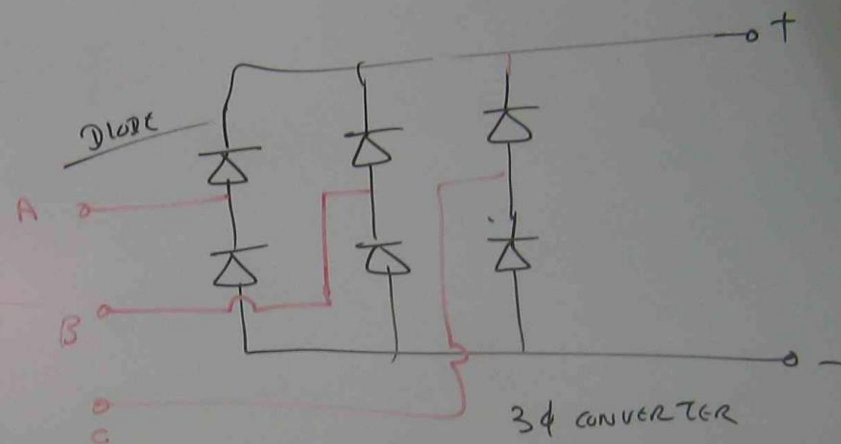
3(a) 7

LOAD STAR / INTERCONNECTED STAR
- ELIMINATE 3rd HARMONICS
- PRIMARY NEUTRAL CAN BE EARTHED
- SUITABLE FOR LARGE STEP DOWN TRANSFORMERS

	DISADVANTAGE	APPLICATION
...EITHER ...INING ...ERATED ...SEE ...AGE	- LOW WINDING SPACE FACTOR - COIL CONSTRUCTION DIFFICULT - HIGHER COST - HIGHER INSULATION STRESS	- VERY LITTLE APPLICATION IN POWER INDUSTRY AS FAULTY TRANSFORMER NEEDS TO BE REMOVED
...RD ...BLE ...ALANCED | UNBALANCED LOAD	NO PRIMARY NEUTRAL FOR EARTHING - A FAULT ON ONE UNIT CAUSES 3φ TO BE INOPERATIVE	STEP DOWN SUPPLY DISTRIBUTION
HARMONIC BALANCED | UNBALANCED LOADS	- NO PRIMARY NEUTRAL FOR EARTHING - A FAULT ON ONE UNIT CAUSES 3φ TO BE INOPERATIVE	TO GIVE SUPPLY TO 3φ CONVERTERS
...RD HARMONIC ...RAL FOR EARTHING	NO SECONDARY NEUTRAL - A FAULT ON 1φ CAUSES 3φ TO BE INOPERATIVE	STEP DOWN TRANSFORMER
3^{rd} HARMONICS NEUTRAL CAN BE EARTHED FOR LARGE STEP DOWN TRANSFORMERS		STEP DOWN TRANSFORMERS.

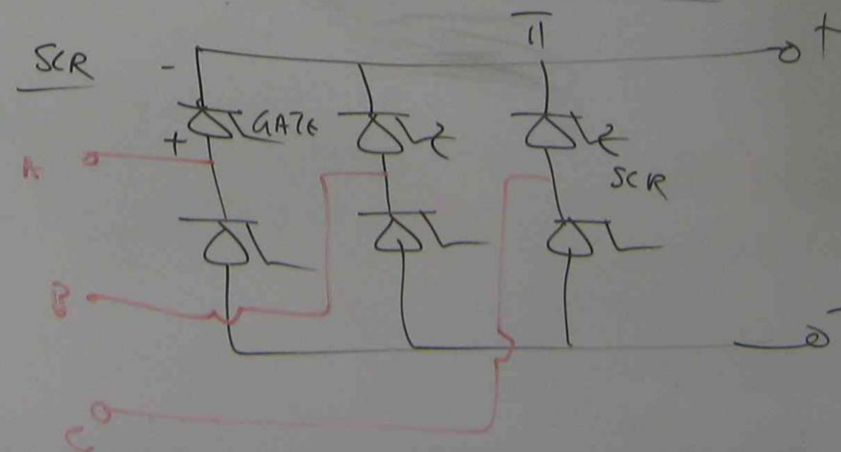


	APPLICATION
	– VERY LITTLE APPLICATION IN POWER INDUSTRY AS FAULTY TRANSFORMER NEEDS TO BE REMOVED
TO BE	STEP DOWN SUPPLY DISTRIBUTION
ϕ TO BE	TO GIVE SUPPLY TO 3ϕ CONVERTERS
E INOPERATIVE	STEP DOWN TRANSFORMER
	STEP DOWN TRANSFORMERS



3ϕ CONVERTER

$$E_{dc} = \frac{2E_{max}}{\pi}$$



ph

10 MVA, $\curlywedge\curlywedge$ TRANSFORMER 33 KV / 11 KV

NO LOAD TEST

LINE VOLTAGE = 11 KV

LINE CURRENT = 15 A

POWER = 75 KW

SHORT CIRCUIT TEST

LINE VOLTAGE = 1650 V LINE TO LINE

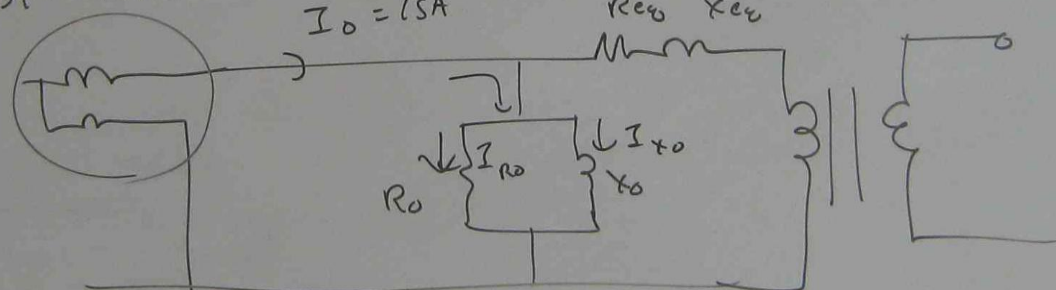
LINE CURRENT = RATED CURRENT

POWER = 90 KW.

DRAW EQUIVALENT CIRCUIT OF TRANSFORMER. ALL COMPONENTS REFERRED TO PRIMARY

OPEN CIRCUIT

$3\phi = 75\,kW$



$$\boxed{R_0 = \frac{V_{ph}^2}{1\phi \text{ POWER}}}$$

$$I_{R0} = \frac{V_{ph}}{R_0}$$

$$I_{X0} = \sqrt{I_0^2 - I_{R0}^2}$$

$$X_0 = \frac{V_{ph}}{I_{X0}}$$

10 MVA, ⅄⅄ TRANSFORMER 33 KV / 11 KV

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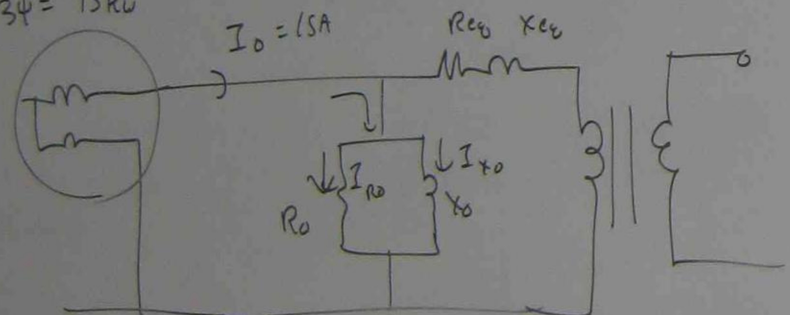
$3\phi = 75\,\text{KW}$



$$\boxed{R_0 = \frac{V_{ph}^2}{1\phi\ \text{POWER}}}$$

$$I_{R0} = \frac{V_{ph}}{R_0}$$

$$I_{X0} = \sqrt{I_0^2 - I_{R0}^2}$$

$$X_0 = \frac{V_{ph}}{I_{X0}}$$

$$V_{ph} = \frac{V_{LINE}}{\sqrt{3}} = \frac{11000}{1.7321} = 6350\ \text{V}$$

$$1\phi\ \text{power} = \frac{3\phi\ \text{POWER}}{3} = \frac{75000}{3} = 25000\ \text{WATT}$$

$$R_0 = \frac{V_{ph}^2}{1\phi\ \text{POWER}} = \frac{6350^2}{25000} = 1613\,\Omega$$

CORE RESISTANCE

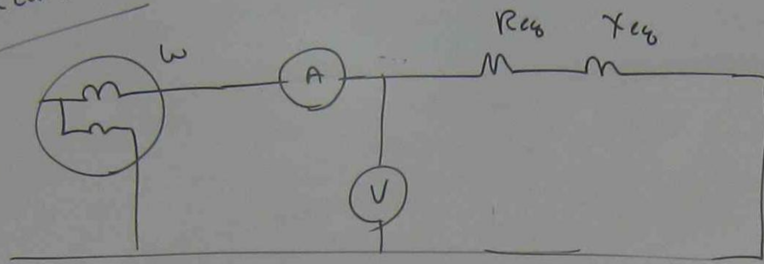
$$I_{R0} = \frac{V_{ph}}{R_0} = \frac{6350}{1613} = 3.94\ \text{Amp.}$$

$$I_0 = 15\ \text{Amp}$$

$$I_{X0} = \sqrt{I_0^2 - I_{R0}^2} = \sqrt{15^2 - 3.94^2} = 14.47\ \text{Amp.}$$

$$X_0 = \frac{V_{ph}}{I_{X0}} = \frac{6350}{14.47} = 438.8\,\Omega$$

SHORT CIRCUIT TEST



$$V_{sc\,ph} = \frac{V_{sc\ LINE}}{\sqrt{3}} = \frac{1650}{\sqrt{3}} = 953\ V$$

$$P_{sc\,1\phi} = \frac{P_{sc\,3\phi}}{3} = \frac{90{,}000}{3} = 30{,}000\ W$$

$$I_{sc} = \text{RATED CURRENT} = \frac{\text{RATED } 3\phi \text{ VA}}{\sqrt{3} \times \text{HIGHER } 3\phi \text{ LINE VOLTAGE}}$$

$$= \frac{10 \times 10^6}{1.7321 \times 33 \times 10^3} = 175\ \text{Amp.}$$

$$\boxed{Z_{eq} = \frac{V_{sc\,ph}}{I_{sc}}}$$

$$Z_{eq} = \frac{953}{175} = 5.4\,\Omega$$

$$\boxed{R_{eq} = \frac{P_{sc\,1\phi}}{(I_{sc})^2}}$$

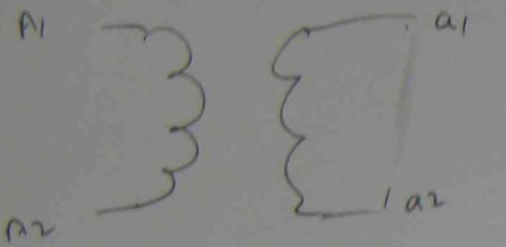
$$R_{eq} = \frac{30{,}000}{(175)^2} = 0.98\,\Omega$$

$$\boxed{X_{eq} = \sqrt{Z_{eq}^2 - R_{eq}^2}}$$

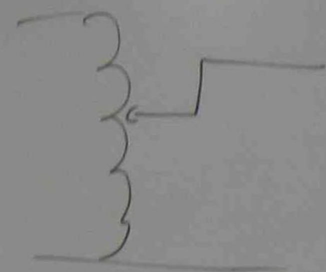
$$= \sqrt{5.4^2 - 0.98^2}$$

$$= 5.3\,\Omega$$

AUTO TRANSFORMER



2 WINDING TRANSFORMER



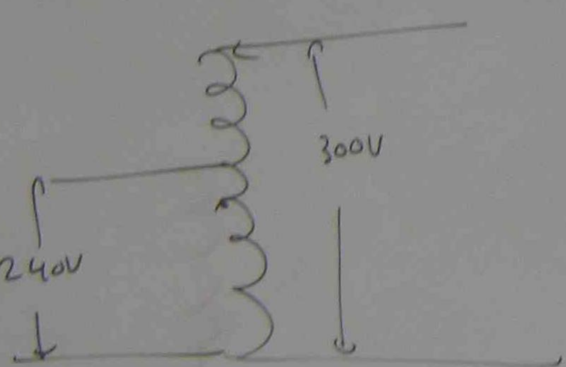
STEP DOWN AUTO TRANSFORMER

(VARIC)

240V — AC

24 | 415V 3φ — AC

240 | 12V — AC



VARIC

STEP UP AUTO TRANSFORMER

ADVANTAGES

- AUTO TRANSFORMERS ARE UTILIZED FOR ELECTRICAL POWER / PRACTICALS / ELECTRICAL TESTING SERVICE TO APPLY GRADUAL INCREASING VOLTAGE FROM ZERO TO MAXIMUM TO ACHIEVE SAFE TESTING.
- IT CAN SAVE COPPER WEIGHT.

DISADVANTAGES

NOT SUITABLE FOR H.V APPLICATIONS