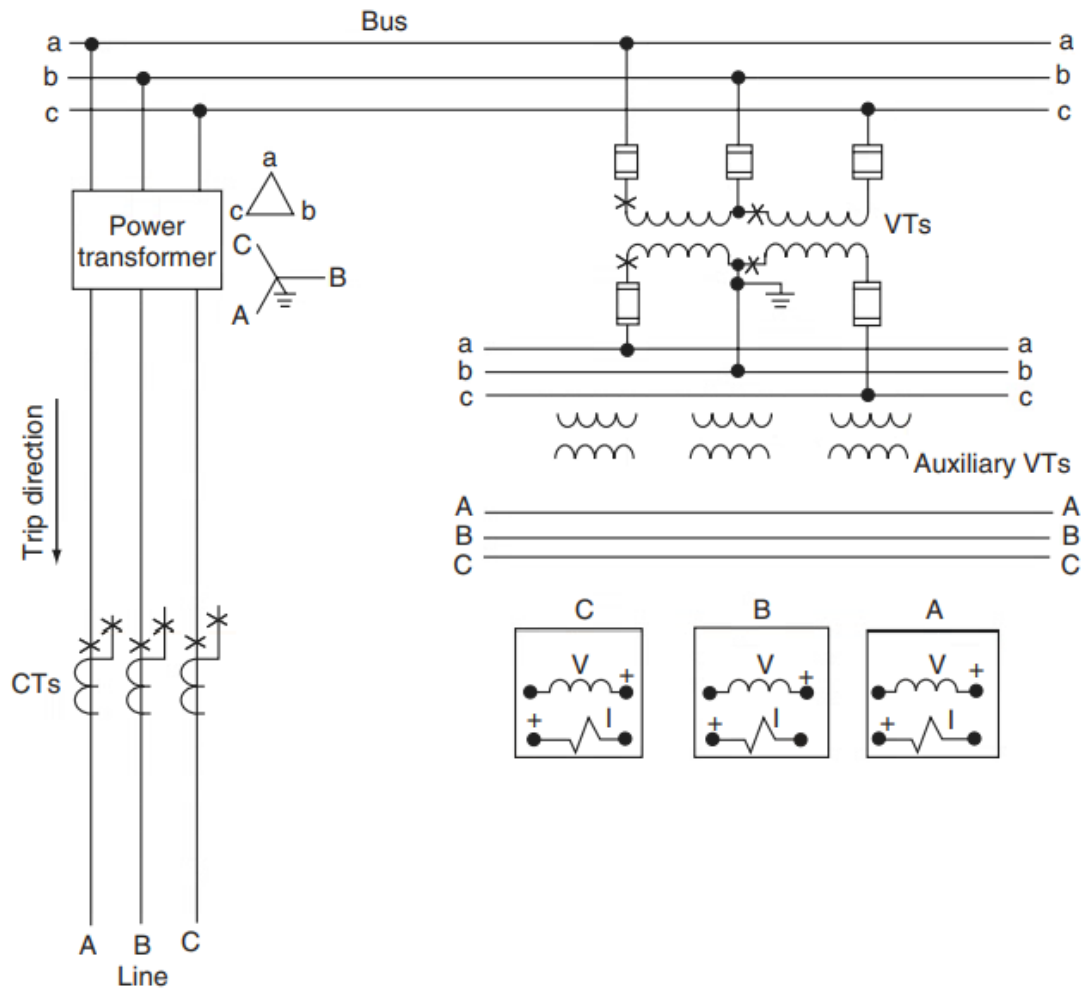


1. Blackburn problem 3.2
2. A utility power system uses ANSI standard transformers in an area with 161kV, 69kV, 34.5kV, and 12.5kV nominal voltage levels. Phase sequence is ABC at 161kV; 1-2-3 at 69,34.5, and 12.5kV. Transformer configurations are Δ -Y for 161/69 and 69/34.5; and Y-Y for 69/12.5kV. At no-load $V_{An} = 93/\underline{0^\circ}$ kV at 161 and $V_{1n} = 20/\underline{0^\circ}$ kV at 34.5 are in phase; and V_{1n} at 69 and 12.5 are in phase; but V_{1n} at 69 lags V_{An} at 161 by 30° .
 - a. If the 161kV ABC phases are connected to H1, H2, H3, respectively, what phases are connected to all other transformer bushings to yield the phase sequences and relative phase angles described. Show your solution by drawing all three 3 Φ transformers with their bushing designations shown, at the correct relative phase angles with your identified system phase adjacent to the bushing designation.
 - b. A new 34.5/12.5kV substation is being built, what ANSI standard transformer winding configuration should be used? Draw your connection solution to align with 2a solution.
3. Given a radial source voltage of exactly 138kV with $Z_{eq} = 0.51 + j15.56$ ohms @138kV to transformer high side (HS). For tap position E-16R of the transformer with tested values in Table below, calculate the following:
 - a. Transformer impedance in ohms at the low side (LS) voltage for that test;
 - b. Transformer impedance in ohms at the high side voltage for that test;
 - c. Transformer impedance in per unit on 100MVA, 138kV base;
 - d. For LS fault, the fault current in low side and high side rms symmetrical amps.

Read Blackburn Chapters 4. (As a minimum page turn to assure you are familiar with this material.)



- 1)
- 2) This was one of my 1987 projects.

% IMPEDANCE AND LOAD LOSS at 85°C. * LTC Reduced Capacity.

Tap Position		MVA	Positive Sequence % Impedance	Load Loss Watts
HV	LV			
A	16R	67.2	10.49	208600
C	16R	67.2	10.58	212600
E	16R	67.2	10.77	219600
A	N	67.2	10.36	222400
C	N	67.2	10.41	223200
C	N	89.6	13.88	397700
C	N	112	17.35	624600
E	N	67.2	10.58	232200
A	16L*	60.48	9.34	206800
C	16L*	60.48	9.37	208900
E	16L*	60.48	9.50	212400

3)

HIGH VOLTAGE TAPCHANGER DE-ENERGIZED OPERATION			
VOLTS L-L	AMPS AT 112.0 MVA	POS	CONNECTS
144900	446	A	3 - 4
141450	457	B	4 - 2
138000	469	C	2 - 5
134550	481	D	5 - 1
131100	493	E	1 - 6

**DANGER: DO NOT OPERATE HV TAP CHANGER
WHEN TRANSFORMER IS ENERGIZED.**

a.

VOLTS L-L	AMPS AT 112.0 MVA	POS	R ON	P1 ON	P4 ON	VOLTS L-L	AMPS AT 112.0 MVA	POS	R ON	P1 ON	P4 ON
37950	1704	16R	B	11	11	34280	1886	1L	A	11	M
37730	1714	15R		10	11	34070	1898	2L		11	11
37520	1723	14R		10	10	33850	1910	3L		10	11
37300	1734	13R		9	10	33640	1922	4L		10	10
37090	1743	12R		9	9	33420	1935	5L		9	10
36870	1754	11R		8	9	33210	1947	6L		9	9
36660	1764	10R		8	8	32990	1960	7L		8	9
36440	1775	9R		7	8	32780	1973	8L		8	8
36230	1785	8R		7	7	32560	1986	9L		7	8
36010	1796	7R		6	7	32340	1999	10L		7	7
35790	1807	6R		6	6	32130	2013	11L		6	7
35580	1817	5R		5	6	31910	2026	12L		6	6
35360	1829	4R		5	5	31700	2040	13L		5	6
35150	1840	3R		4	5	31480	2054	14L		5	5
34930	1851	2R		4	4	31270	2068	15L		4	5
34720	1862	1R		M	4	31050	2083	16L		4	4
34500	1874	RN		M	M						

b.