

Topics for Today:

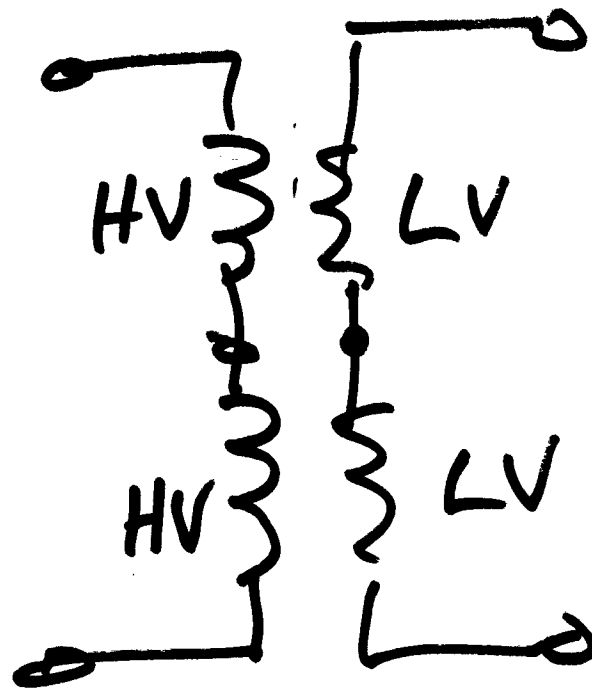
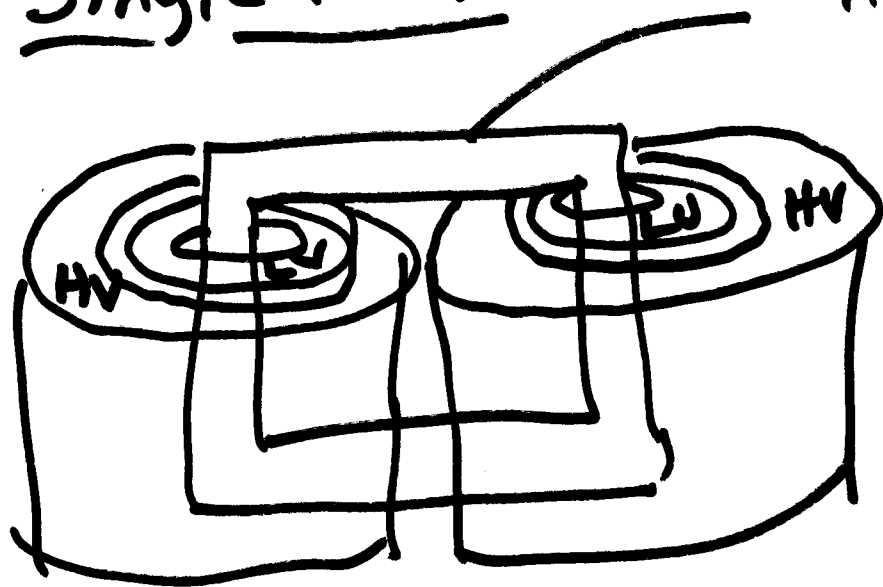
- Course Info:
 - Web page: <https://pages.mtu.edu/~bamork/ee5220/>
 - Book, references, syllabus, more are on web page.
 - Software - Matlab. ATP/EMTP [License - www.emtp.org] ATP tutorials posted on our course web page
 - EE5220-L@mtu.edu (participation = min half letter grade)
- HW#9 - Probs. 9.2, 9.3, 9.4 were due Tues.
- Mid-term equivalent: homework re-works and ATP skills demo.
- Term Project - Journal paper analysis - beginning analysis - due Mon Apr 11th
- Transformer modeling
 - Three-phase transformer core structures
 - Three phase modeling
 - Available ATP transformer models
 - Ideal transformer, single-phase transformer
 - BCTRAN, XFMR models
 - Factory test report data sheets - typically only source of info
- Next: Lightning, insulation coordination - Chapters 14 and 15.

Transformer Models

- Core Structure - vital: I_{ex} , inrush, Sw. Transients

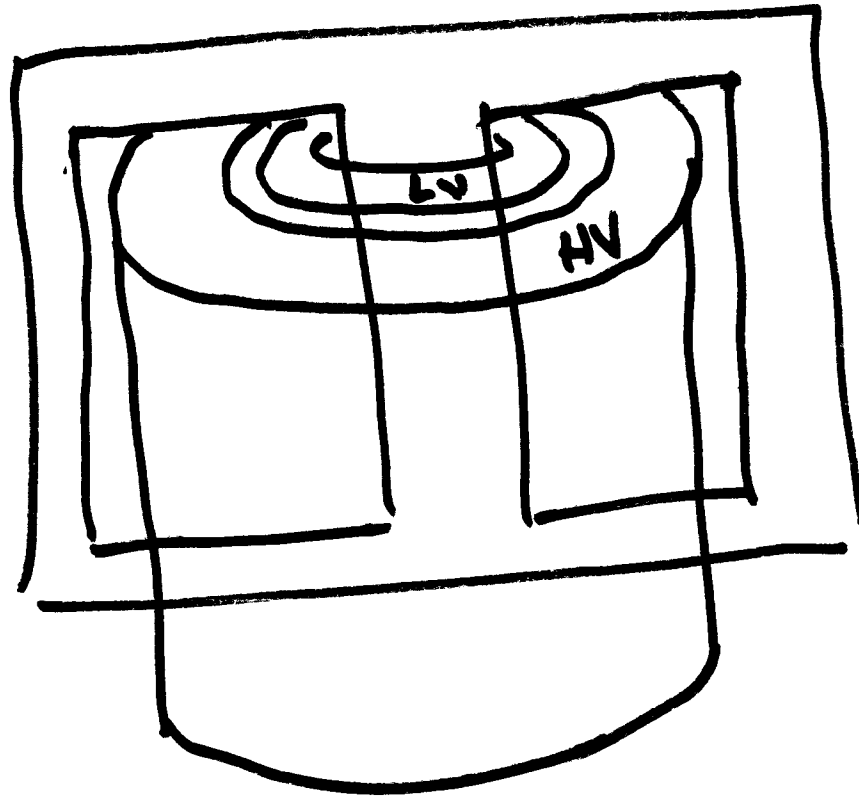
Single Phase:

"Core Form"



Cylindrical coils
Core - "S-P"
 ↑ ↑
Second Pri

Single Phase - "Shell Form"

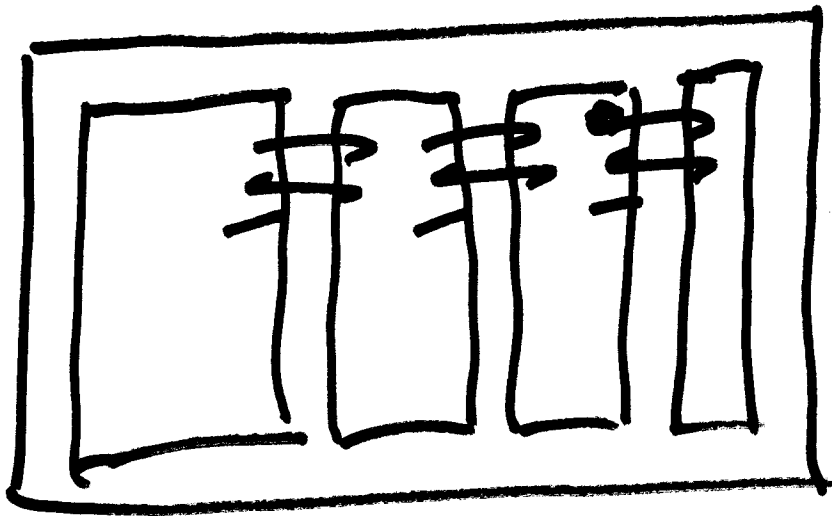


"S-P"

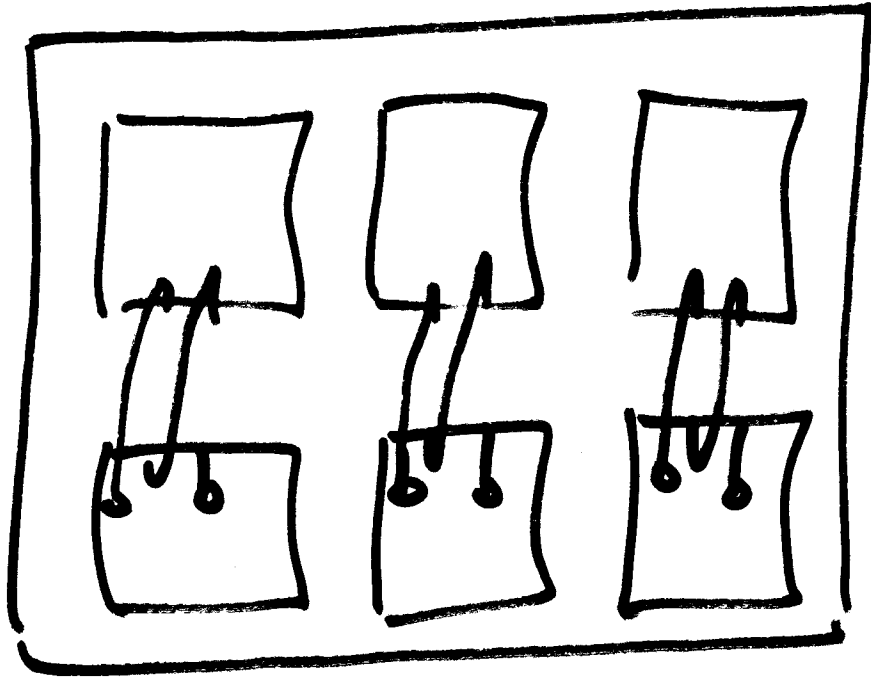
3-Phase Cores



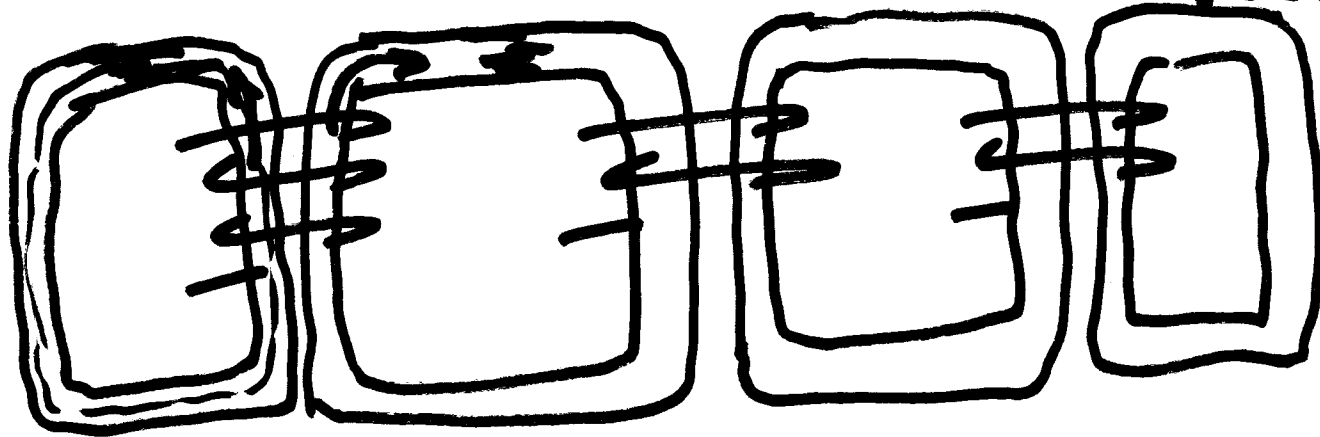
- Core-form
Also - 3-Legged core



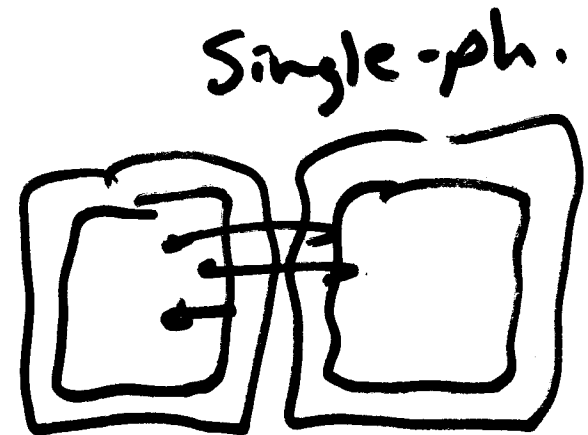
- 5-Legged core



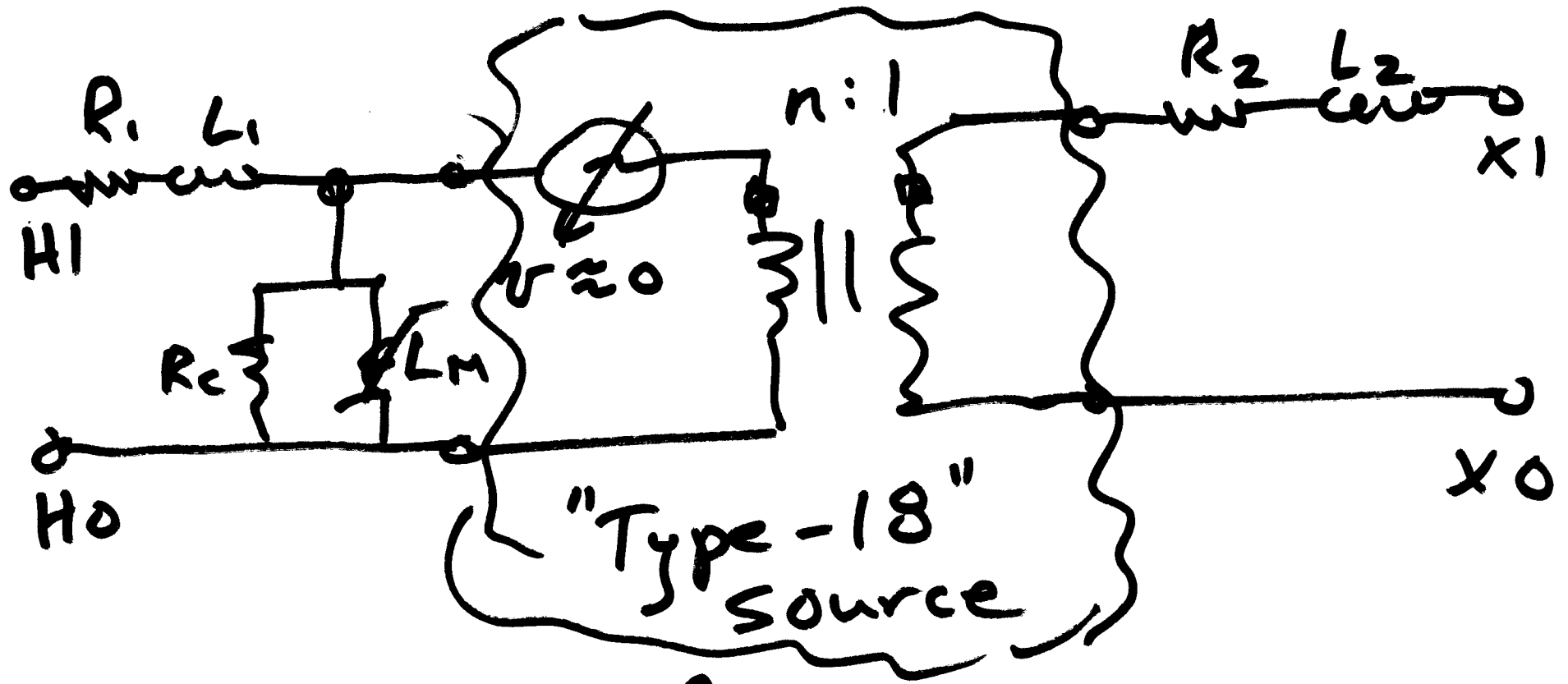
Shell form.

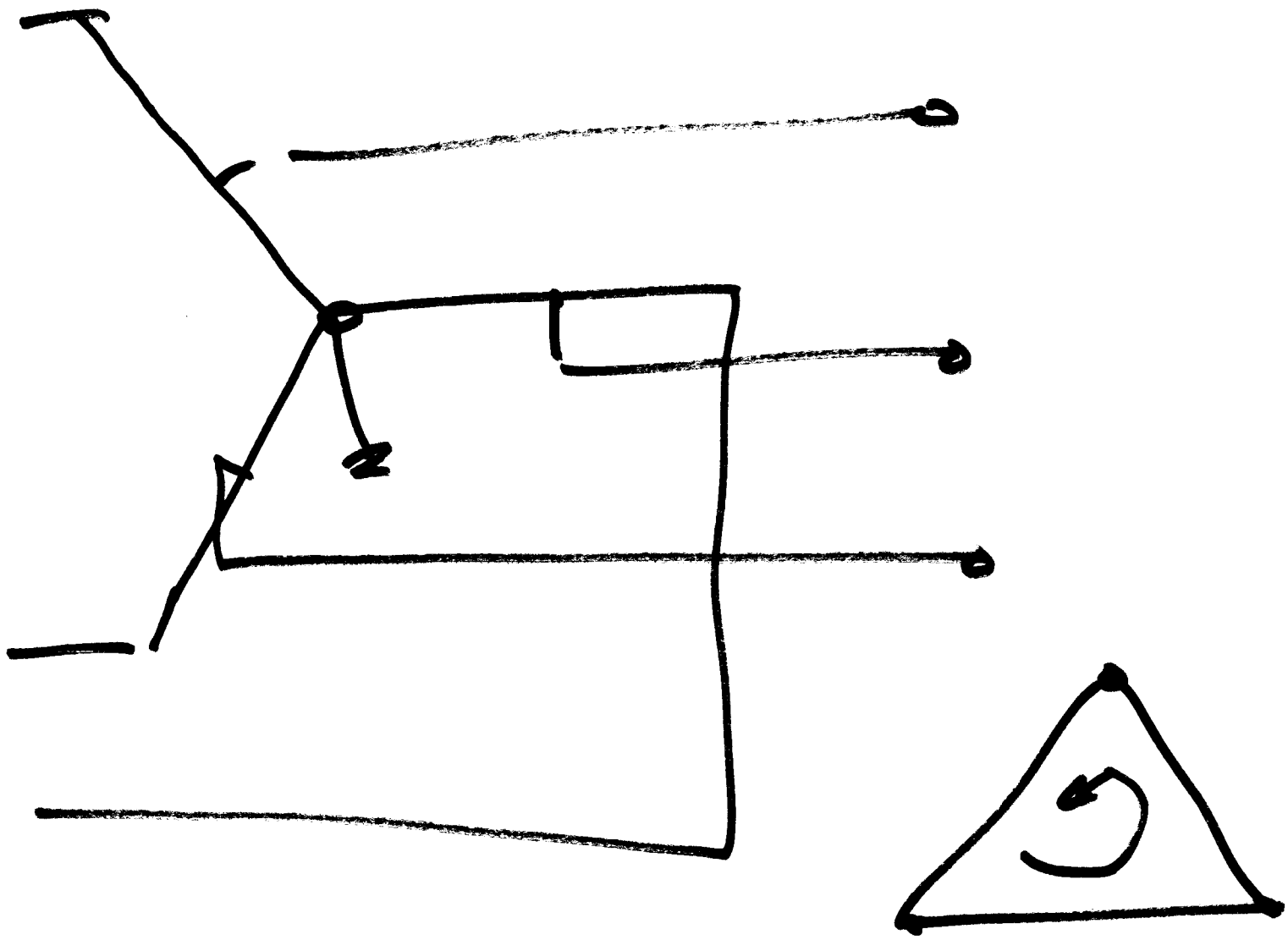


3-ph.
Wound Core

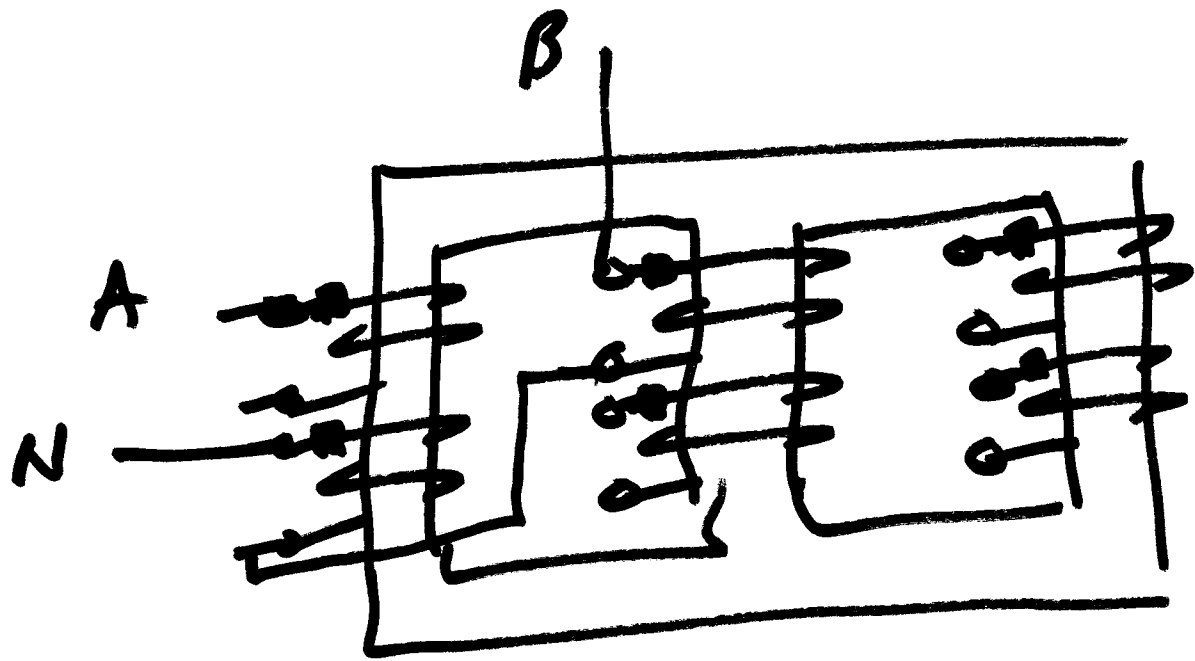
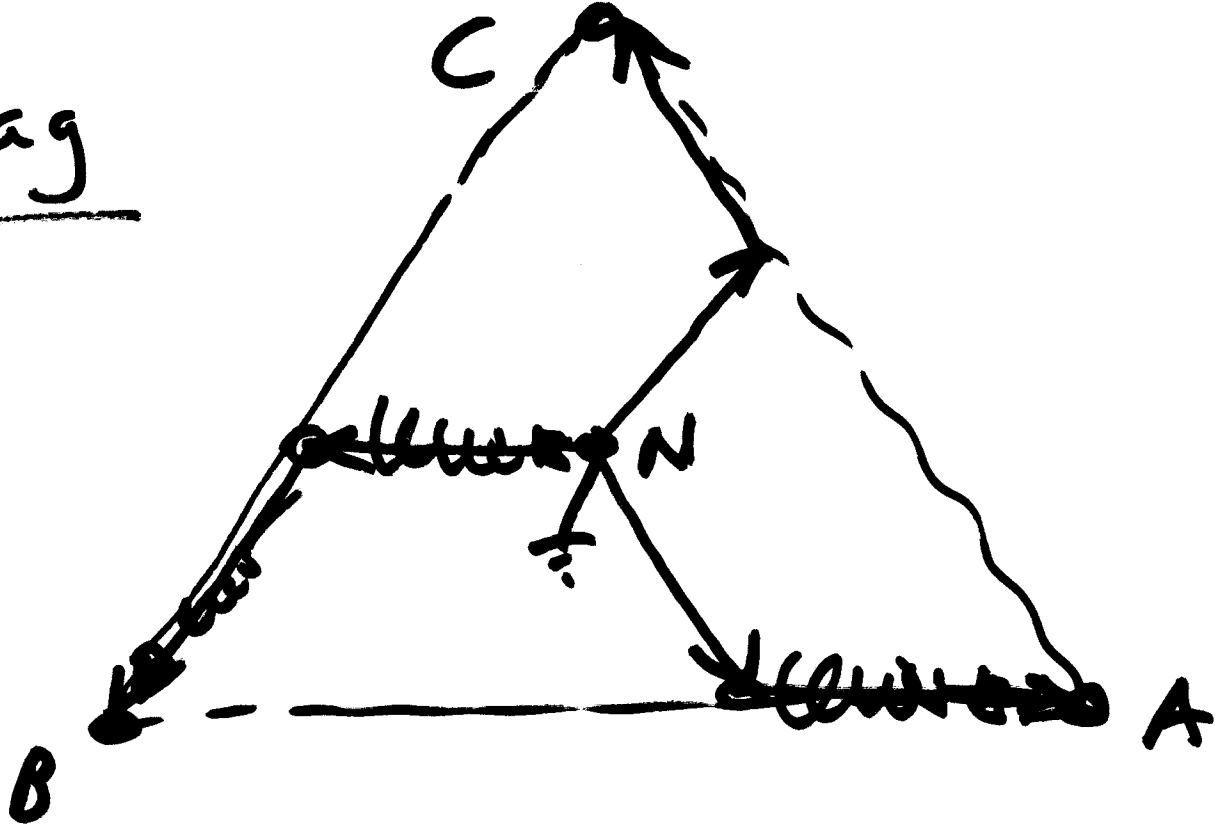


Single-ph.

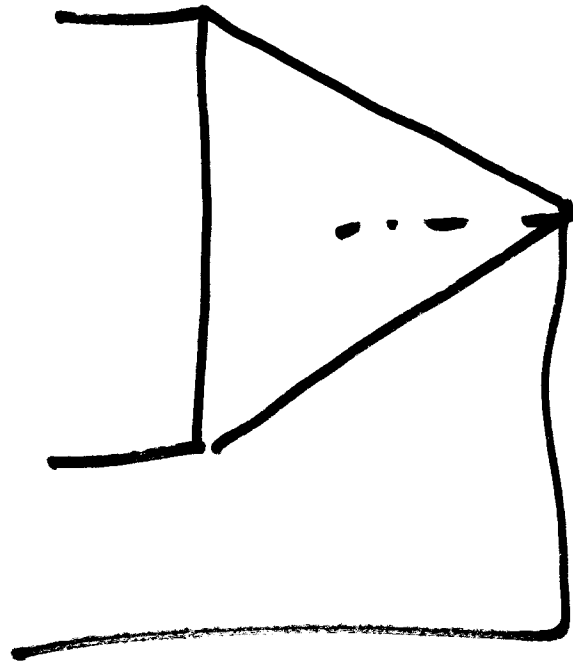




Zig-Zag



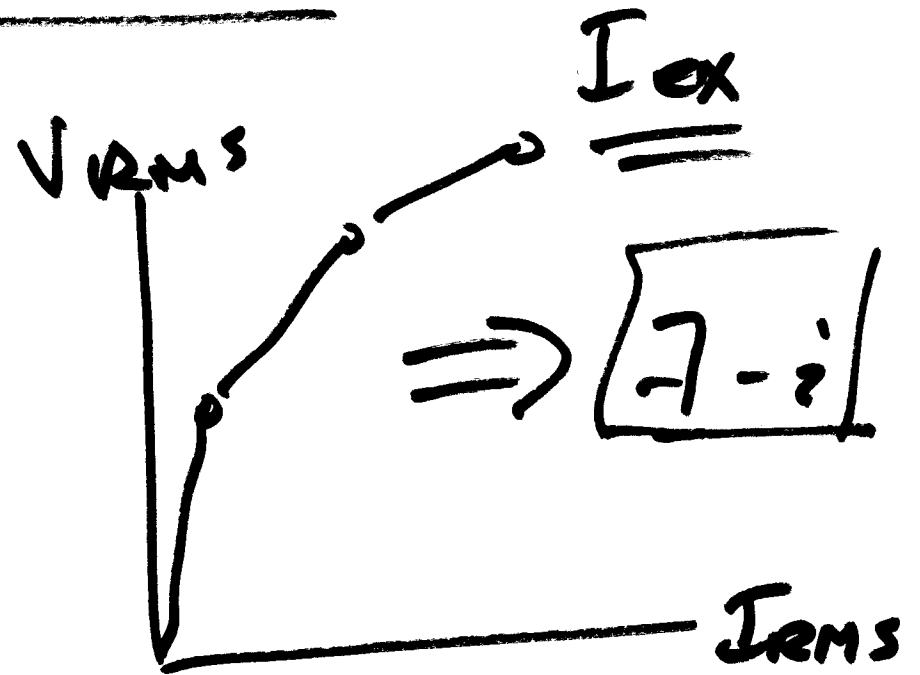
High Z_0



Δ - Zig-zag

3-Phase Power XFMRs

BC TRAN -



Hybrid or XFMR - Model

APPENDIX C: TRANSFORMER FACTORY TEST REPORT

TRANSFORMER TEST REPORT

Date of Test 6/3/71 Customer's Order C-67899 Our Order C-04070-5
 Type OA/FOA/FOA Phase 3 Cycles 60 Rise 55°/65°C Taps See N.P. Dwg. #307256 Spec. 13018
 H. V. Volts 345000 Grd. Y/199200 L. V. Volts 118000 Grd. Y/68200 T.V. Volts 13800A
 KVA 296000/394000/490000 * KVA 296000/294000/490000 * KVA 77000/102667/128333 *

Serial Number			C-04070-5-1	Guarantees
Polarity See <u>N.P. Dwg. #307256</u>	Transf. Conn.:	345000-118000	Volts @ 296 MVA	
W.M. Copper Loss @ Full Load 75°C			376940	
Core Loss @ 100% Voltage			✓ 297600	310000
Total Loss @ Full Load 100% Voltage			676540	605000
Core Loss @ 110% Voltage			** 402240	390000
% Exciting Current @ 100% Voltage			✓ 0.77	1.00
% Exciting Current @ 110% Voltage			1.71	2.00
% Impedance @ 75°C		Zps	6.21	6.30
% Resistance @ 75°C			0.128	
% Reactance @ 75°C			6.20	
% Regulation @ 100% P.F. Full Load			0.32	0.33
% Regulation @ 80% P.F. Full Load			3.94	4.05
Efficiency @ Full Load 100% P.F.			99.77	99.76
Efficiency @ ¾ Load 100% P.F.			99.77	99.75
Efficiency @ ½ Load 100% P.F.			99.73	99.71
Efficiency @ ¼ Load 100% P.F.			99.56	99.55
Total H.V. Resistance in Ohms @ 75°C (Series Wdg. - Tap "A")			0.6756	
Total L.V. Resistance in Ohms @ 75°C (Common Wdg.)			0.1635	
Total T.V. Resistance in Ohms @ 75°C			0.01748	
% Impedance @ 75°C (345000-118000 Volts) 296 MVA		Zpt	55.9	55.0
% Impedance @ 75°C (118000-138000 Volts) 296 MVA		Zst	42.1	40.0
INSULATION TESTS				
and to T.V.				
H.V. & L.V./and Core	Volts for 1 Min.		50000	50000
T.V. to Core	Volts for 1 Min.		34000	34000
Induced Voltage in H.V. Winding Line to Ground			460000	460000
Induced VOLTS Voltage in H.V. Winding Line to Line			575000	575000
TEMPERATURE RISE				
Connected: 362000-118000 Volts	MVA	296	394	490
Copper Rise Corrected to Shutdown °C	Series Wdg.	42.4	43.5	47.9
	Common Wdg.	43.3	43.3	47.5
Oil Rise °C		51.4	33.7	33.2

Unless otherwise specified the above Tests are in accordance with the latest A. S. A. and N. E. M. A. Standards.

Remarks: @ 77000 KVA @ 102667 KVA @ 128333 KVA
 T.V. Gradient °C: 10.9 15.5 19.0
 * KVA @ 65°C Rise: H.V. and L.V. 330000/440000/550000; T.V. - 86240/114987/143733.
 ** The Core Loss Value Exceeding Guarantee was submitted to and accepted by the customer.
 This transformer satisfactorily withstood Impulse Tests. See Impulse Test Report.
 This transformer satisfactorily withstood Switching Surge Tests. See Switching Surge Test Report.
 See Page #2 for additional test performance data.