Topics for Today:

• Course Info:
  • Web page:  [http://www.ee.mtu.edu/faculty/bamork/ee5220/](http://www.ee.mtu.edu/faculty/bamork/ee5220/)
  • Book, references, syllabus, more are on web page.
  • Software - Matlab. ATP/EMTP [ License - [www.emtp.org](http://www.emtp.org) ] ATP tutorials posted on our course web page
  • EE5220-L@mtu.edu (participation = half letter grade, 5%)

• HW#9 - Probs. 9.2, 9.3, 9.4 were due Monday.
• Mid-term: Apr 5-9th time window.
  • On-campus - sign out from ECE Secretary
  • On-line - e-mail Dr. Mork and Grader to request
• Term Project - Journal paper analysis - beginning analysis - due Mon Apr 5th
• 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: Iex, inrush, Sw. Transients

Single Phase:
"Core Form"

Cylindrical coils
Core = "S-P"

Second Pri
- 5-legged core
- Also 3-legged core
- Core - former
- 3-phase cores
Shell form.

3-ph. Wound Core

Single-ph.
3-Phase Power XFMRs

BCTRAN -

\[ \frac{I_{ex}}{I_{rms}} \Rightarrow \sqrt{1 - i} \]

Hybrid or XFMR - Model
APPENDIX C: TRANSFORMER FACTORY TEST REPORT

TRANSFORMER TEST REPORT

Date of Test: 6/3/72  Customer's Order: C-67899  Our Order: C-01-070-5

Type/PA/POA/PA  Phase: 3  Cycles: 60  Rise 55°/65°  Tape: See N.P. Dwg. #327256  Spec. 12018


KVA 225000/321000/149000  KVA 225000/291000/149000  KVA 77000/102667/128333

<table>
<thead>
<tr>
<th>Serial Number</th>
<th>640-070-5-1</th>
<th>Guarantee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polarity</td>
<td>See N.P. Dwg. #327256</td>
<td>Transform. Core.: 165000-118000 Volts &amp; 296 MVA</td>
</tr>
<tr>
<td>W.M. Copper Loss ±100 % Voltage</td>
<td>375000</td>
<td>310000</td>
</tr>
<tr>
<td>Core Loss ±100 % Voltage</td>
<td>225000</td>
<td>310000</td>
</tr>
<tr>
<td>Total Loss ±100 % Voltage</td>
<td>65550</td>
<td>65000</td>
</tr>
<tr>
<td>Core Loss ±110 % Voltage</td>
<td>132200</td>
<td>350000</td>
</tr>
<tr>
<td>% Exciting Current ±100 % Voltage</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>% Exciting Current ±110 % Voltage</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>% Impedance ±15 °C</td>
<td>0.21</td>
<td>0.30</td>
</tr>
<tr>
<td>% Resistance ±75 °C</td>
<td>0.123</td>
<td>0.1</td>
</tr>
<tr>
<td>% Regulation ±100 % P.F. Full Load</td>
<td>0.32</td>
<td>0.33</td>
</tr>
<tr>
<td>% Regulation ±80 % P.F. Full Load</td>
<td>3.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Efficiency ±100 % P.F. Full Load</td>
<td>99.77</td>
<td>99.75</td>
</tr>
<tr>
<td>% T. Loss ±100 % P.F. Full Load</td>
<td>99.77</td>
<td>99.75</td>
</tr>
<tr>
<td>% Efficiency ±120 % P.F. Full Load</td>
<td>99.56</td>
<td>99.55</td>
</tr>
<tr>
<td>Total K.V. Resistance in Ohms ±75 °C (Series Wdg. - Tap &quot;A&quot;)</td>
<td>0.6755</td>
<td></td>
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<tr>
<td>Total K.V. Resistance in Ohms ±75 °C (Origin Wdg.)</td>
<td>0.1515</td>
<td></td>
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<tr>
<td>Total T.V. Resistance in Ohms ±75 °C</td>
<td>0.0175</td>
<td></td>
</tr>
<tr>
<td>% Impedance ±75 °C (245000-149000 Volts)</td>
<td>0.23</td>
<td>0.3</td>
</tr>
<tr>
<td>% Impedance ±75 °C (321000-291000 Volts)</td>
<td>0.23</td>
<td>0.23</td>
</tr>
</tbody>
</table>

**INSULATION TESTS**

- H.V., L.V. and Core Volts for 1 Min.: 50000 50000
- T.V. to Core Volts for 1 Min.: 30000 30000
- Induced Voltage in H.V. Winding Line to Ground: 150000 150000
- Induced-Motorswitch Voltage in H.V. Winding Line to Line: 575000 575000

**TEMPERATURE RISE**

- Connected: 362000-118000 Volts
- Copper Rise Corrected to Shutdown °C: 51.3 33.7 33.2
- Oil Rise °C: 51.3 33.7 33.2

Remarks:
- @ 77000 KVA @ 102667 KVA @ 128333 KVA
- T.V. Gradient: 10.9 15.3 19.0
- KVA @ 65 °C Rise: H.V. and L.V. 330000/440000/550000; T.V. 86200/11987/13733.
- **The Core Loss Value Exceeding Guarantee was submitted to and accepted by the customer.**
- Page #2 for additional test performance data.