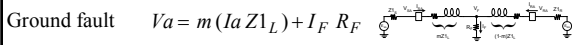


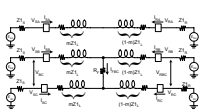
Fault Location

- Fault locating for multi-terminal lines
- Two approaches:
 - With communications
 - Without communications
- Start by writing loop equations (Ohm's law)

Ground fault $V_a = m(I_a Z_{L1}) + I_F R_F$



Phase fault $V_{bc} = m(I_{ab} Z_{L1}) + I_F R_F$



4/11/2005

ECE 526 Power System Protection II
- Lecture 31

1

Fault Location

- Single ended fault calculations for multi-terminal lines
- Two simple methods
 - simple reactance (been there – done that)
 - algorithm based on work by Takagi
- Reactance method
 - Measures apparent impedance

$$V_{a_S} = m Z_{L1} (I_{a_S} + I_{a_0} K_0) + (I_{a_S} + I_{a_R}) R_F$$

$$X_{L\ apt} = \text{Im} \left[\frac{V_a}{I_a} \right] \quad m = \frac{X_{L\ apt}}{\text{Im}(Z_{L1})}$$

4/11/2005

ECE 526 Power System Protection II
- Lecture 31

2

Fault Location

- Works well
 - Homogeneous systems
 - Low fault resistance
 - Low power flow
- Errors caused by R_F : Ignore or eliminate
 - Ignoring – assumes best case scenario
 - Elimination – Use negative sequence current

$$m = \frac{\text{Im}[V_{as} \overline{I_{as2}}]}{\text{Im}[Z_{L1} (I_{as} + k_0 \cdot 3 \cdot I_{a0}) \overline{I_{as2}}]}$$

4/11/2005

ECE 526 Power System Protection II
- Lecture 31

3

Fault Location

- Takagi method
 - does not use I_{A2}^* or I_R^*
 - Uses complex conjugate of a superposition term
 - Requires good pre-fault data
 - T. Takagi, et. al., "Development of a New Type Fault Locator Using the One-Terminal Voltage and Current Data", IEEE Transactions on Power Apparatus and Systems, Vol. PAS-101, No. 8, August, 1982.

- Superposition term:
 - $I\phi$ pre-fault - $I\phi$ post-fault

$$\alpha = (I\phi_{PRE_FAULT} - I\phi_{POST_FAULT})$$

4/11/2005

ECE 526 Power System Protection II
- Lecture 31

4

Fault Location

- Read for next time
 - Selected papers link
 - 6001.pdf (SEL)
 - 6089.pdf (SEL)
 - review of methods.pdf (ABB)