Fault Analysis

SCHOOL OF ELECTRICAL AND ELECTRONIC ENGINEERING

Bachelor of Engineering (Hons) BE in Elect/Cont/Comm/Comp Eng

Program Code: (DT021A)

<YEAR 4>

Name of Module: (Power System Analysis, POWS4601)

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1. Introduction to Fault Analysis

Fault Analysis helps in exploring the faults that occur in the power networks. Which provides useful data for protection settings and stability expectations. There are various types of faults in the power transmission line that can occur however, four main types of faults occur more often as follows:

- Single line to ground
- Line to line
- Three-phase to the ground (balanced)
- Line to line to ground

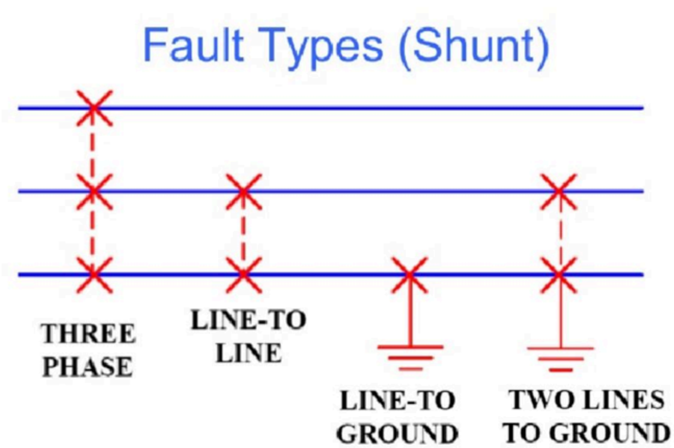

Figure 1 - Types of faults in power network [1]

The figure above shows the types of faults, and the most common fault is a Single line to the ground which occurs approximately 75% of the time and a three-phase balanced fault occurs least likely approximately 5% of the time.

Assumptions are also made to simplify the fault analysis:

- At the time fault, the system is operating at no load which means there is no load current so pre-fault currents before the fault are zero.
- All emf of the generators in the system are operating per unit. Which is
- Shunt component elements are ignored
- Transient effects are neglected

2. Objectives Preparation:

The purpose of this assignment is to analyze fault in a network where each phase, currents and the phase voltages are effected. The system will be designed in this experiment for solving symmeterical and asymetrical faults at where the faults are occured. The ditribustion system is provided as shown in figure 2 along with a sequence reactances on a 100 MVA base in Table 1 and volatge levels throughout the system shown in KV in Table 2. In the example below fault is occured at bus 3.

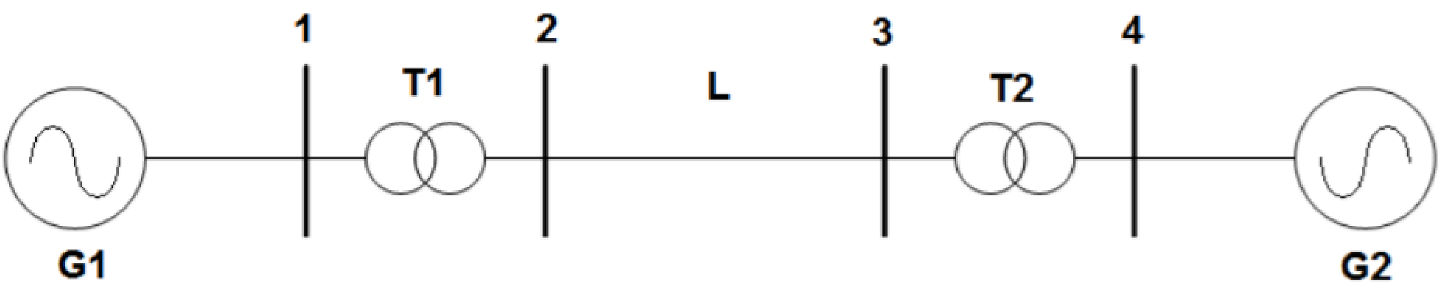

Figure 1: A section of the distribution system

	G1	T1	L	G2	T2
X_1	0.12	0.12	0.05	0.14	0.14
X_2	0.12	0.12	0.05	0.14	0.14
X_0	0.11	0.12	0.05	0.13	0.14

Table 1: Sequence reactances (p.u. on 100 MVA base)

	G1	T1	L	G2	T2
V_{BASE}	3	3/42	42	4	42/4

Table 1: Voltage bases (kV)

Asymmetrical Fault: Line-Line

```
%inputs in order Z1, Z2, Z0 so eg. XG1(1) is the positive sequence
%reactance of G1 and XG1(3) is the zero sequence reactance
XG1 = i*[0.12 0.12 0.11];
XT1 = i*[0.12 0.12 0.12];
```

```
XL = i*[0.05 0.05 0.05];
XG2 = i*[0.14 0.14 0.13];
XT2 = i*[0.14 0.14 0.14];

%  Voltage inputs
VG1 = 3;
VT1 = 3/42;
VL = 42;
VG2 = 3;
VT2 = 42/4;

%User inputs:
%type = input('What type of fault has occured?\n');
ZF = 0;
%%% try for different faults and
```

2. Network Impedence Matrix

```
%Z = [0.05 0.05 0.05]6nnn
%G1 = (XG1 * XG2);
Z = [XG1+XT1+XL+XG2+XT2];
```

3. Thevenin Equivalent Impedance

```
%Zth = i*(XG1 + XT1);
Zth = ((XG2+XT1+XL).*(XT2+XG2))./Z;
% Xth
%Xth = (XG1+XT1+XL).*(XT2+XG2)./(XG1+XT1+XL+XT2+XG2);
```

4. The A - Matrix

```
a = complex(cos(120*pi/180),sin(120*pi/180));

A = [a^0 a^0 a^0
     a^0 a^2 a^1
     a^0 a^1 a^2]
```

```
A = 3×3 complex
   1.0000 + 0.0000i   1.0000 + 0.0000i   1.0000 + 0.0000i
   1.0000 + 0.0000i  -0.5000 - 0.8660i  -0.5000 + 0.8660i
   1.0000 + 0.0000i  -0.5000 + 0.8660i  -0.5000 - 0.8660i
```

```


A_inverse = inv(A);
```

5. Symmetrical Fault

```
% I012 = A^-1 * IABC
% IA = IF, IB, a^2*IF, a*IF
% Three phase balanced fault

%Fault Current
```

```
%IF = complex(real())

%Single phase fault
E = 1;
IF1 = E./(XG1+XT1+XL);
IF2 = E./(XT2+XG2);
IF = IF1+IF2;

% Voltages:
V0 = -I*Z(3); % we cannot use zeros instead using 3
V1 = E - Z(1)*I; %
V2 = -I*Z(2);

VABC = A*V012; % In Cartesian form
```

Displaying output

```
disp('________________________________________')
```

```
________________________________________
```

```
disp('       Networking impedence Matrix      ')
```

```
       Networking impedence Matrix
```

```
disp('________________________________________')
```

```
________________________________________
```

```
disp(Z)
```

```
   0.0000 + 0.5700i   0.0000 + 0.5700i   0.0000 + 0.5500i
```

```
disp('  ')
```

```
disp('  ')
```

```
disp('________________________________________')
```

```
________________________________________
```

```
disp('      Thevenin Equivalent Impedance     ')
```

```
      Thevenin Equivalent Impedance
```

```
disp('________________________________________')
```

```
________________________________________
```

```
disp(Zth)
```

```
   0.0000 + 0.1523i   0.0000 + 0.1523i   0.0000 + 0.1473i
```

```
disp('   ')
```

```
disp('   ')
```

```
disp('________________________________________')
```

```
________________________________________
```

```
disp('                The A - Matrix                ')
```

```
                The A - Matrix
```

```
disp('________________________________________')
```

```
________________________________________
```

```
disp(A)
```

```
   1.0000 + 0.0000i   1.0000 + 0.0000i   1.0000 + 0.0000i
   1.0000 + 0.0000i  -0.5000 - 0.8660i  -0.5000 + 0.8660i
   1.0000 + 0.0000i  -0.5000 + 0.8660i  -0.5000 - 0.8660i
```

```
disp('   ')
```

```
disp('   ')
```

```
disp('________________________________________')
```

```
________________________________________
```

```
disp('              Symmetrical Fault             ')
```

```
Symmetrical Fault
```

```
disp('_________________________________________')
```

```
 _______________________________________
```

```
disp('      Fault Current       ')
```

```
      Fault Current
```

```
disp(IF)
```

```
   0.0000 - 7.0197i   0.0000 - 7.0197i   0.0000 - 7.2751i
```

```
disp('      Voltages ABC in Cartesian form    ')
```

```
      Voltages ABC in Cartesian form
```

```
disp(VABC)
```

```
   0.1306 + 0.0000i
  -0.4238 - 0.8660i
  -0.4238 + 0.8660i
```

References

[1] "Types of Faults in Power System | Unsymmetrical Faults in Power System | Electrical Academia", *Electrical Academia*, 2021. [Online]. Available: https://electricalacademia.com/electric-power/types-faults-power-system-unsymmetrical-faults-power-system/. [Accessed: 20- Nov- 2021]