Sri Vidya College of Engineering And Technology

Virudhunagar – 626 005

Department of Electrical and Electronics Engineering

SHORT QUESTIONS AND ANSWERS

Year/ Semester/ Class : III/ V/ EEE Academic Year: 2015-2016

Subject Code/ Name: EE6501/ Power System Analysis

UNIT III FAULT ANALYSIS – BALANCED FAULTS

1. Write the relative frequency of occurrence of various types of faults.

S.No.	Type of fault	Relative frequency of occurrence
1.	Three phase fault	5%
2.	Double line-to-ground fault	10%
3.	Line- to-line fault	15%
4.	Single line-to-ground fault	70%

2. Find the fault current in Fig.2, if the pre-fault voltage at the fault point is 0.97 p.u.?

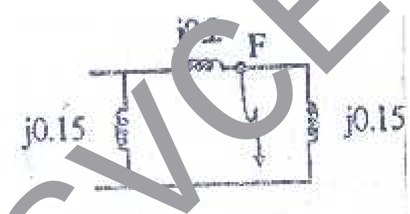


Fig. 2

3. What are the assumptions made in short circuit studies of a large power system network?

- Representing each machine by a constant voltage source behind proper reactances which may be X”, X’ or X.
- Pre fault load currents are neglected.
- Transformer taps are assumed to be nominal.
- Shunt elements in the transformer model that account for magnetizing current and core loss are neglected.
- A symmetric three phase power system is considered.
- Shunt capacitance of the transmission line is ignored.
- Series resistances of transmission lines are neglected.
- The negative sequence impedance of alternators are assumed to be the same as their positive sequence impedance.$Z_1=Z_2$

4. What are the reactances used in the analysis of symmetrical faults on the synchronous machines as its equivalent reactance?

1. Sub transient reactance X_d''
2. Transient reactance X_d'
3. Synchronous reactance X_d

5. What is the reason for transients during short circuits?

The faults or short circuits are associated with sudden change in currents. Most of the components of the power system have inductive property which opposes any sudden change in currents so the faults (short circuit) are associated with transients.

6. **Define short circuit interrupting MVA of a circuit breaker.**

The short circuit interrupting MVA of a circuit breaker is the volt-amperes (power) flowing through it at the moment of opening its contacts due to a fault.

It is estimated by the following equations

Short circuit interrupting MVA = $\sqrt{3}\left|V_{pL}\right|\left|I_{fL}\right|$

Short circuit interrupting MVA = $\left|V_{pL,p.u}\right|\left|I_{fL,p.u}\right|$ MVA_b

Where,

$\left|I_{fL}\right|$ **=Magnitude of line value of short circuit interrupting current at the fault in kA.**

$\left|V_{pL}\right|$ **= Magnitude of line voltage at the fault point in kV.**

$\left|I_{fL,p.u}\right|$ **= Magnitude of short circuit interrupting current at the fault in p.u.**

$\left|V_{pL,p.u}\right|$ **= Magnitude of prefault voltage at the fault point in p.u..**

7. **Define short circuit capacity of power system (or) fault level.**

Short circuit capacity or short circuit MVA or fault level at a bus is defined as the product of the magnitudes of the pre fault bus voltage and the post fault current.

8. **What is meant by doubling effect?**

If a symmetrical fault occurs when the voltage wave is going through zero then the maximum momentary short circuit current will be double the value of maximum symmetrical short circuit current. This effect is called doubling effect.

9. **What is momentary current rating of circuit breaker? How it is estimated.**

The momentary current rating is the maximum current that may flow through a circuit breaker for a short duration. It is estimated by multiplying the symmetrical sub transient fault current by a factor of 1.6.

10. **What is interrupting short circuit current rating of circuit breaker? How it is estimated.**

The interrupting short circuit current rating of the circuit breaker is the maximum current that may flow through it when its contact open due to fault. It is estimated by multiplying the transient short circuit current by a factor of 1.0 to 1.5.The value of the factor depends on the speed of the breaker.

11. **List the various types of shunt faults.**

The various types of shunt faults are

- Line to ground fault
- Line to line fault
- Double Line to ground fault
- Three phase fault

12. **What is the need for short circuit analysis?**

The short circuit studies are essential in order to design or develop the protective schemes for various parts of the system. The protective scheme consists of current and voltage sensing devices, protective relays and circuit breakers. The selection of these devices mainly depends on various currents that may flow in the fault conditions.

13. List the various types of shunt and series faults.

The various types of shunt faults are

- Line to ground fault
- Line to line fault
- Double Line to ground fault
- Three phase fault

The various types of series faults are

- One open conductor fault
- Two open conductor fault

14. List the symmetrical and unsymmetrical faults.

The three phase fault is the only symmetrical fault. All other types of faults are unsymmetrical faults are unsymmetrical faults.

The various unsymmetrical faults are

- Line to ground fault
- Line to line fault
- Double Line to ground fault
- One or two open conductor fault.

15. Name any two methods of reducing short circuit current.

- By providing neutral reactance
- By introducing a large value of shunt reactance between buses.

17. Define DC off-set current.

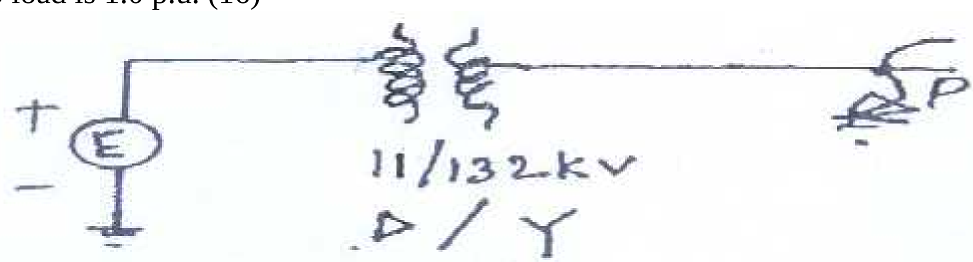
The unidirectional transient component of short circuit current is called DC off-set current.

PART – B

1. A generator is connected through a transformer to a synchronous motor the sub transient reactance of generator and motor are 0.15 p.u. and 0.35 p.u. respectively. The leakage reactance of the transformer is 0.1 p.u. All the reactances are calculated on a common base. A three phase fault occurs at the terminals of the motor when the terminal voltage of the generator is 0.9 p.u. The output current of generator is 1 p.u. and 0.8 p.f. leading. Find the sub transient current in p.u. in the fault, generator and motor. Use the terminal voltage of generator as reference vector. (16)

2. Explain the step by step procedure for systematic fault analysis using bus impedance matrix. (16)

3. A 60 MVA, Y connected 11 KV synchronous generator is connected to a 60 MVA, 11/132 KV Δ/Y transformer. The sub transient reactance X''_d of the generator is 0.12 p.u. on a 60 MVA base, while the transformer reactance is 0.1 p.u. on the same base. The generator is unloaded when a symmetrical fault is suddenly placed at point p as shown in Fig. 3 Find the sub transient symmetrical fault current in p.u. amperes and actual amperes on both side of the transformer. Phase to neutral voltage of the generator at no load is 1.0 p.u. (16)

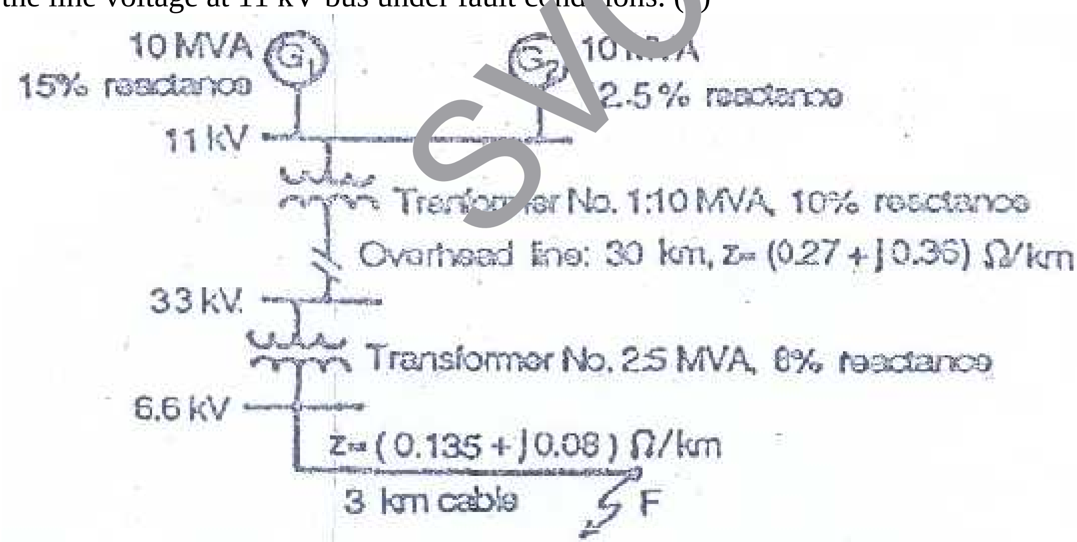


4. A three –phase transmission line operating at 33 kV and having a resistance and reactance of 5 Ohms and 15 Ohms respectively is connected to the generating station bus-bar through a 5000 KVA step up

transformer which has a reactance of 0.05 p.u. Connected to the bus-bars are two alternators, are 10,000 KVA having 0.08 p.u. reactance and another 5000 KVA having 0.06 p.u. reactance. Calculate the KVA at a short circuit fault between phases occurring at the high voltage terminals of the transformers. (16)

5. A synchronous generator and a synchronous motor each rated 25 MVA, 11 kV having 15% sub-transient reactance are connected through transformers and a line as shown in fig. The transformers are rated 25 MVA,11/66 KV and 66/11 kV with leakage reactance of 10% each. The line has a reactance of 10% on a base of 25 MVA, 66 kV. The motor is drawing 15 MW at 0.5 power factor leading and a terminal voltage of 10.6 KV. When a symmetrical 3 phase fault occurs at the motor terminals. Find the sub-transient current in the generator, motor and fault.(16)

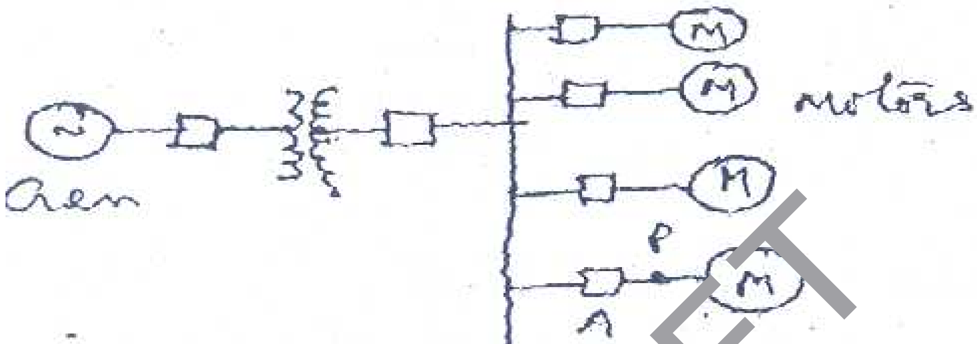
6. A three phase power of 700 MW is to be transmitted to a substation located 315 kM from the source of power. For a preliminary line design assume the following parameters:
   V_s = 1.0 p.u., V_r + 0.9 p.u. λ = 5000 km ; z_c = 320 Ω, and $\acute{S}$ = 36.870 .
   (i)Based on the practical line load ability equation, determine a nominal voltage level for the transmission line. (8)
   (ii)For the transmission voltage level obtained in (i) Calculate the theoretical maximum power that can be transferred by the transmission line. (8)
7. With a help of a detailed flowchart, explain how a symmetrical fault can be analyzed using Z_{bus} ? (16)
8. (i) For the radial network shown below a three phase fault occurs at F. Determine the fault current and the line voltage at 11 kV bus under fault conditions. (6)



   (ii) Explain the procedure for making short-circuit studies of a large power system networks using digital computers. (10)
9. Two synchronous machines are connected through three phase transformers to the transmission line shown in Fig.11 the ratings and reactance of the machines and transformers are
   Machine 1 and 2 : 100 MVA, 20kV; $X''_d = X_1 = X_2$ = 20%
   X_0 = 4%, X_n = 5%
   Transformers T_1 and T_2 : 100 MVA, 20 Δ/345 Y kV ; X = 8%.
   On a chosen base of 100 MVA, 345 kV in the transmission line circuit the line reactances are $X_1 = X_2$ = 15% and X_0 = 50%. Draw each of the three sequence networks and find the zero sequence bus

impedance matrixes by means of Z_{bus} building algorithm. (16)

10. A 25,000 KVA, 13.8 kV generator with X"d = 15% is connected through a transformer to a bus which supplies four identical motors as shown in Fig. 7 The sub transient reactance X"d of each motor is 20% on a base of 5000 KVA, 6.9 kV. The three-phase rating of the transformer is 25,000 KVA, 13.8/6.9 kV, with a leakage reactance of 10%. The bus voltage at the motors is 6.9 kV when a three-phase fault occurs at point p. for the fault specified, determine (i) the sub transient current in the fault (ii) the sub transient current in breaker A and (iii) the symmetrical short-circuit interrupting current in the fault and in breaker A. (16)



11. Determine Zbus for the network shown below in Fig. 8 where the impedances labeled 1 through 6 are shown in per unit. Preserve all buses. (16)

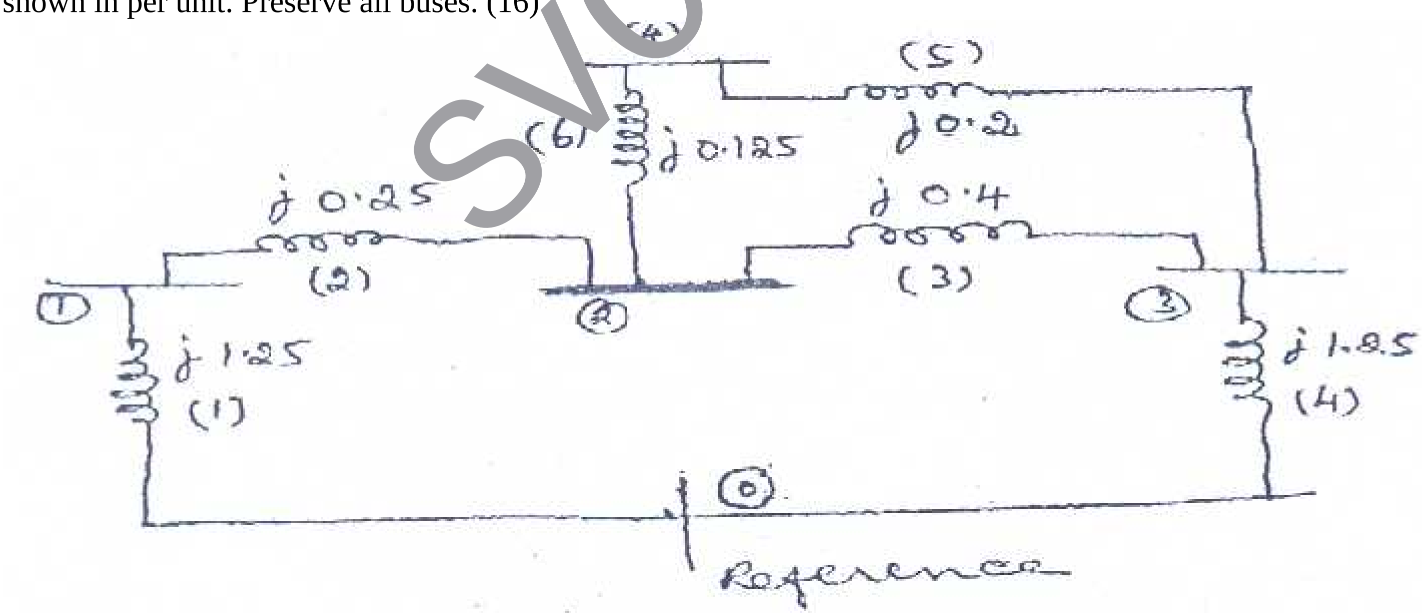


Fig. 8 Branch impedances are in p.u. and branch numbers are in parentheses.