

EE8010-POWER SYSTEM TRANSIENTS

UNIVERSITY QUESTIONS AND ANSWERS

UNIT-I INTRODUCTION AND

SURVEY

PART-A

10. Define transient.(N/Dec-2016,N/Dec-2014,N/D2011)

The power system transient is the outward manifestation of a sudden change in circuit conditions as when a switch opens or closes or a fault occurs on a system.

11. What are the causes of transients?

(N/D2017,A/M2017,M/J2016,A/M2015, N/D2015 ,M/J2012)

The various causes of transients can be classified as

- Internal causes (device switching and arcing)
- External causes (lightning and poor electrical connections)

Internal Causes:

Facility load switches
On/off disconnects
Capacitor banks switch
Tap changing (transformers)

External Causes:

Lightning strikes
Poor or loose connection
Accidents and Human error.
Weather and animals

12. What are the effects of transients in power systems?(N/D2017,A/M2011)

- Under severity, black out of power system will be produced.
- Lightning transient produced steep fronted wave on transmission line.
- Travelling wave produced due to transient will shutter the insulations and weak poles.
- Cause damage to windings of transformer and generators.

13. Write down the importance of transient study in power system planning. (N/D2017,N/D2011)

- Designing and planning
- If severe transients occurred it would end up with partial block-out or total block-out.
- Switching transients geared to the system voltage cause severe damage.
- For economic reason also we have to limit and control the switching surges.

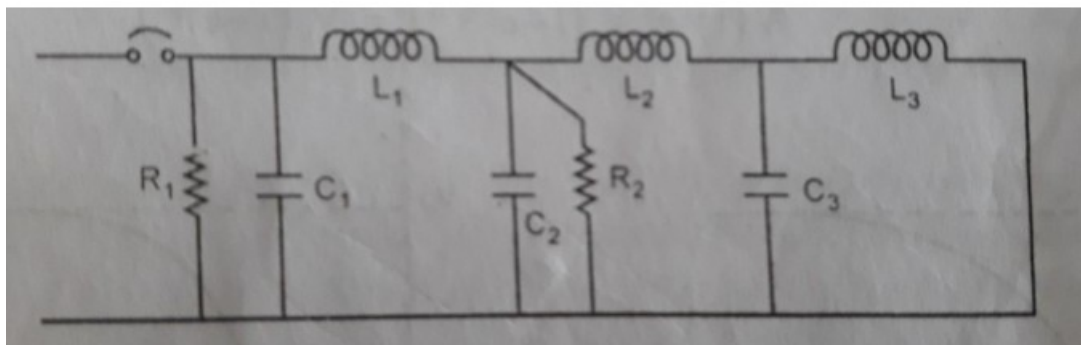
- The transients produced in one region travel towards the remote end and cause difficulties at that region also. Since integrated power system is required.

14. List the types of power system transients. (A/M2017, M/J2014, M/J2012,)

1. Ultra transients
2. Medium fast transients
3. Slow transients

Power system transients based on waveform shapes can be classified into “oscillator transients” and “impulsive transients” and “Multiple transients”

15. Draw the double frequency transient with an example. (A/M2017, N/D2013)



To determine the recovery transient voltage we have to analyze the circuit. If it is possible to find the source side transient and load side transient and circuit with natural frequencies.

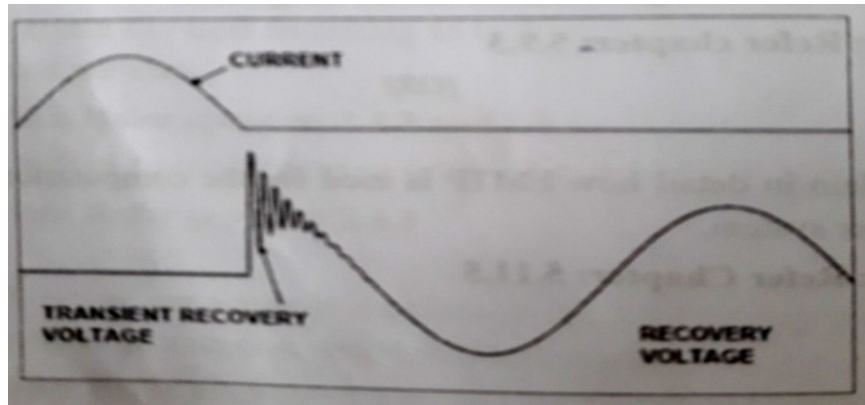
16. A power transformer draws a heavy magnetizing inrush current. Now this current is suddenly interrupted before it reaches natural zero by means of a circuit breaker. What would happen between the contacts of circuit breaker? What do you call this phenomenon? (M/J2016, N/D 2015,)

Current Chopping.

17. Write the basic transform of RLC circuit transient. (A/M 2015)

$$I_L(s) = V_c(0) / L \cdot 1/s^2 + s / T_p + 1/T^2$$

18. Draw the TRV wave form across the circuit breaker following the interruption of fault current. (M/J 2016).



19. Write the mathematical expression for RLC circuit transient. (N/D2014).

$$i(t) = e^{-\alpha t} (B_1 \cos \omega dt + B_2 \sin \omega dt)$$

$$V(t) = (A_1 \cos \omega dt + A_2 \sin \omega dt) \text{ for parallel circuit.}$$

20. Find the Laplace transform of $1/s(s+a)$ (N/D2016)

$$1/s(s+a) = 1/s \cdot 1/s+a$$

$$\text{Inverse Laplace Transform for } 1/s(s+a) = 1 \cdot e^{-\alpha t} = e^{-\alpha t}$$

21. Define transient recovery voltage.

A transient voltage is developed across the contacts of a switch when they start to open. This voltage, known as transient recovery voltage (TRV), is present immediately after the current zero, and in actual system its duration is in the order of milliseconds.

22. What is ground wire?

Ground wire is a conductor run parallel to the main conductor of the transmission line supported on the same tower and earthed at every equally and regularly spaced towers. It is run above the main conductor of the line.

23. Define power system transient.

As per the classic definition in concerned, an instantaneous change in the state leading to a burst of energy for a limited time is termed as a transient event. The causes can be both internal and external, with the aftermath being sequential and affecting the other parts too. As per classification, we have the impulsive and oscillatory transients.

24. What are the types of power system Transients?

- (a) Based upon origin
- (b) Based upon the made of generation of transients
- (c) Based on transient classification with respect to the frequency group
- (d) Classification of transients on frequency ranges
- (e) Classification depending on its nature
- (f) Classification depends on control on t
- (g) How and where transients are generated,
- (h) Effects of lightning transient

UNIT-II SWITCHING TRANSIENTS

1. **What is current chopping?** (A/M2017, M/J2016, N/D2016, M/J2014, N/D2013, N/D2012, M/J2012)

When interrupting low inductive currents such as magnetizing currents of the transformer shunt reactor, the rapid deionization of the contact space and blast effect may cause the current to be interrupted before the natural current zero. This phenomenon of interruption of the current before its natural zero is called **current chopping**.

2. **What do you mean by ferro resonance?**

(N/D2017, A/M2015, N/D2014, M/J2014, N/D2011, A/M 2011)

Ferro resonance or non linear response is a type of resonance in electric circuits which occurs when a circuit containing a non-linear inductance is fed from a source that has series capacitance, and the circuit is subjected to a disturbance such as opening of a switch.

3. **What is resistance switching?**(M/J2016, N/D2016, M/J2012, N/D 2011, A/M 2011)

A deliberate connection of a resistance in parallel with the contact space (arc) is made to overcome the effect of transient recovery voltage. This is known as resistance switching.

4. **What is the need for resistance switching?**(A/M 2008)

The shunt resistors are connected across circuit breaker have two functions.

- To distribute the transient recovery voltage more uniformly across the several breaks.
- To reduce the severity of transient recovery voltage at the time of interruption by introducing damping in to oscillation.

5. **What is current suppression?**

When interrupting low inductive currents such as magnetizing currents of the shunt reactor, the rapid deionization of the contact space and blast effect may cause the current to be interrupted before the natural current zero. This phenomenon of interruption of the current before its natural zero is called **current chopping(or) Current suppression**.

6. **What is meant by abnormal switching transients?** (A/M2017, M/J2013, N/D2011)

Due to some other circumstances like transients the voltage and current magnitude may rise high. The transient occur due to the trapping of the energy and its subsequent release somewhere in the circuit. Such transients are referred as abnormal current and voltage transients.

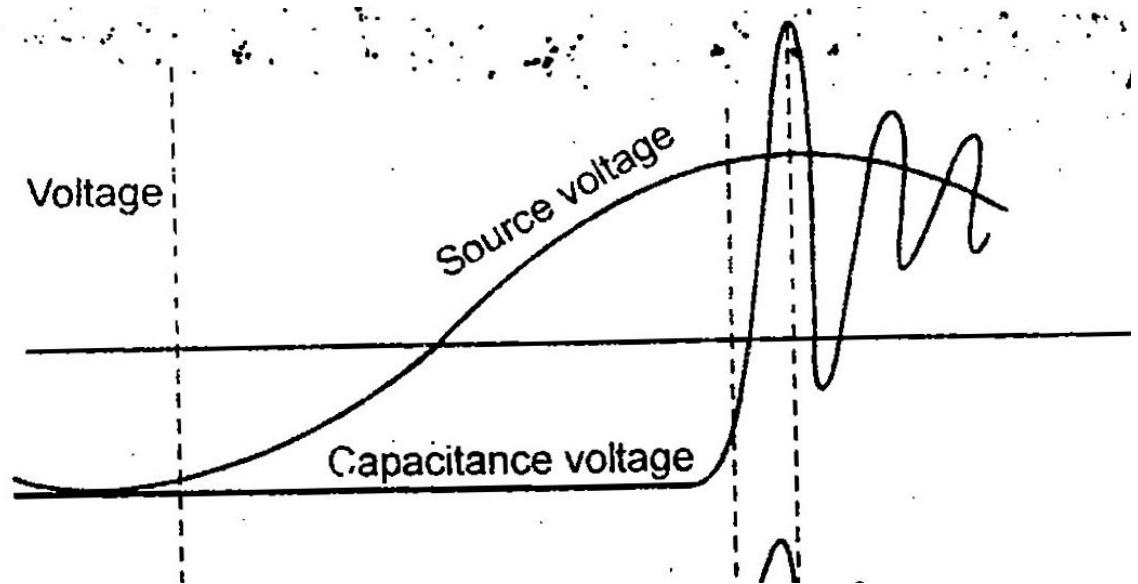
7. **Where do double re-strike transients arise? What are their implications?** (N/D2016, N/D2015)

When the switch operates in such a circuit it completely divorcés the load from the supply. There after the two halves of the circuit behave independently.

8. Give a power system example for the occurrence of ferro resonance. (A/M2017, M/J2013)

1. Opening one (or) two phases, either intentionally (or) accidentally
2. The cable system had either light load (or) no load.
3. Common place UD cable service drop from an overhead line.

9. Sketch the re strike waveform of the capacitance switching.



10. What is the origin of ferro-resonance? What are the undesirable effects? (N/D2016, N/D2015)

Origin: Non-linear inductance and capacitive components.

Effects: Generation of harmonics the order of harmonics are 5th (or) higher harmonics.

11. Why multiple restrike occur due to capacitance switching? (N/D2014)

Some capacitance will exist on the source side of the breaker which will introduce higher frequency disturbances. So multiple restrike occur during capacitance switching.

12. What is meant by multiple restriking transients? (M/J2013)

When a couple of re-ignitions occur is called multiple restrike, very high voltages build up across the interrupting chamber, and it is most likely that a flashover takes place on the outside chamber of the interrupter.

13. Differentiate normal and abnormal switching transients. (N/D2012)

Normal switching transients are circumstances in which voltage or current within the normal peak values Closing switch or circuit in a dominantly capacitive or inductive network results in inrush currents which can cause problems for the protection system.

Abnormal switching transients are circumstances in which voltage or

current are far in excess of twice in normal peak values. Insulation of high voltage circuit breakers typically can over voltages up to 2.5 times over its normal voltage.

14. What is capacitance switching? (M/J2008)

The shunt capacitors are employed to correct a lagging power factor, or in some cases, to provide support for the system. In some applications they are switched in and out quite frequently as the system load varies and the system voltage fluctuates.

15. Define arcing ground. (N/D 2007)

If neutral of three phase wires was not earthed in long enough voltage transmission lines a serious problems called arcing ground is produced. The arcing ground produces severe oscillations of three to four times the normal voltage.

16. What does the phenomenon of current suppression lead to?(M/J2013)

Rapid deionization of contact space and may cause the current to be interrupted its natural zero.

17. What is meant by switching surges?(N/D-2006)

The disturbance produced by the switching operation in a system which sets up travelling wave which travel along the connected lines to and fro. These disturbances are called switching surges.

UNIT-III LIGHTNING TRANSIENTS

1. **What is the significance of tower footing resistance?(A/M 2017,M/J2016, N/D 2013)**

- A low value of tower footing resistance results in less voltage stresses across line insulation
- A tower footing resistance of 20Ω for EHV lines and 10Ω for HV lines provides sufficient lightning protection.

2. **What is tower footing resistance?(A/M2015, N/D2014, N/D2011)**

Tower footing resistance is the resistance offered by tower footing to the dissipation of current. The effective of a ground wire depends to a large extent on the lower footing resistance.

3. **What is ground wire?(N/D2016)**

It is the conductor run parallel to the main conductor of the transmission line supported on the same tower and earthed at every equally regularly spaced tower. It is run above the main conductor of the line.

4. **How would you modeling a lightning strike?(A/M2017, N/D2015, M/J2014)**

The modeling of lightning strike behavior and estimation of the subsequent electric discharge is of great practical importance. In this study, a complete two- dimensional physics-based analytic formulation is presented for elevated grounded systems that can be envisioned to be contained within two non- concentric circular domains.

5. **Write the equation for tower footing resistance.(N/D2017)**

$$\text{Resistance} = \frac{\rho}{2\pi R}, R = \text{radius of sphere.}$$

6. **What is called charge formation?(A/M2017,A/M2011)**

During thunderstorms positive and negative charge becomes separated by the heavy air currents with ice crystals in the upper part and rain in the lower part of the cloud. This charge separation depends on the height of clouds which range from 0.2 t 10Km with their charge centers probably at a distance of about 0.25 to 2Km.

7. **What are the protective devices used to protect power system equipments against lightning? (N/D2016, N/D2013, N/D2009)**

- | | | |
|----------------------|----------------------|--------------------|
| (a) Ground wires | (d) Rod Gaps | (g) Expulsion gaps |
| (b) Surge arresters | (e) Surge arresters | |
| (c) Protective tubes | (f) Protective tubes | |

8. **What are the properties of good transmission line? (N/D2016, N/D2013, N/D2009)**

- (a) Reduce the number of outages
- (b) High ground impedance or tower footing resistance is to be avoided
- (c) Incidence of strokes

(d) High surge impedance in ground wires, tower structures are to be avoided.

9. Define iso keraunic level or thunderstorm days.(N/D2016,N/D2009)

It is the number as the number of days in a year when the thunder is heard recorded in a Particular location. Often it does not distinguish between the ground strokes and the cloud-cloud strokes.110 state the factors influence the lightning induced voltages on transmission lines. The ground conductivity, the leader stroke current and the corona.

10.What are the types of protection afforded by ground wires? (M/J2016, A/M2015)

A shield wire reduce the magnitudes of the over voltage associated with nearby strokesAs this effect is due to the coupling between the shield and phases wires, the voltage reduction will occur regardless of the position of the shield wire with respect to the phase conductors.The greater the coupling, the more significant is the voltage reduction. The effectiveness of the shield wires in improving the indirect lightning performance of distribution lines.

11.Mention any two factors which are contributing to good line design.(M/J2014, N/D2013)

- We try to keep the incidence of strokes to the system to a minimum.
- The objective of good line design is to reduce the number of outages caused by lightning.

12.Differentiate between direct and indirect lightning stroke.

Direct lightning stroke is the one which strikes either the phase conductors or the tower or shield (ground wire generates very high voltages in the power line Indirect lightning stroke is a very high voltage can be generated in the power line due to the stroke which hits the nearby ground. Such strokes are called indirect lightning stroke or induced lightning stroke.

UNIT-IV TRAVELING WAVES ON TRANSMISSION LINE
COMPUTATION OF TRANSIENTS.

1. Define lumped parameters.(N/D2017, A/M2010)

The lumped element (also called lumped parameters (or) lumped components) simplifies the description of the behavior of spatially distributed physical system in to a topology Consisting of discrete entities that approximate the behavior of the distributed system under certain assumptions.

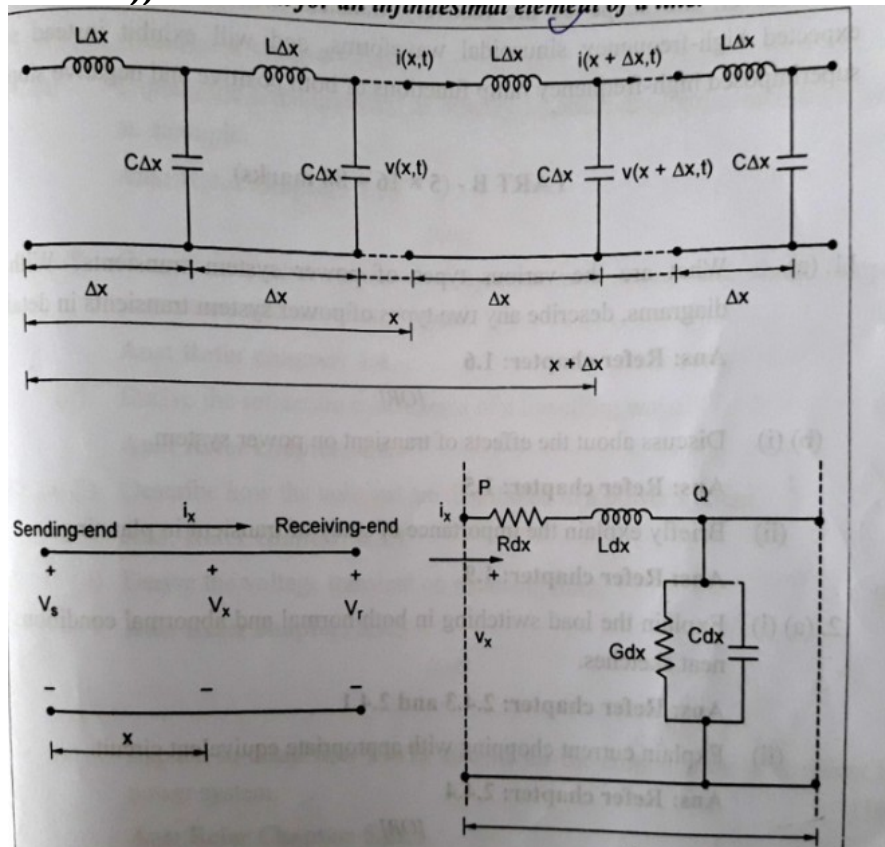
2. What are the specifications of travelling wave? (N/D2017)

A travelling wave is characterized by the four specifications Crest of a wave, Front of a wave, Tail of a wave and polarity.

3. What is the importance of Bewley's Lattice diagram?(A/M2017,N/D2014 A/M2015)

In a complex electrical network with number of interconnections and with various terminations, the travelling wave initiated by single incident wave will upstart with a considerable rate as the wave splits. Due to this multiple reflection occur. It is possible for the voltage to build up certain points by the reinforcing action of several waves. In order to study such effects, Bewley proposed transient

4. Draw the equivalent circuit foran infinitesimal element of a line. (A/M2017, N/D2013,M/J2016))



5. What are the standing waves?(A/M-2017, N/D-2014)

6. A standing wave, also known as stationary wave, is a wave that remains in a constant position. This phenomenon can occur because the medium is moving in the opposite direction to the wave, or it can arise in a stationary medium as a result of interference between two waves travelling in opposite directions.

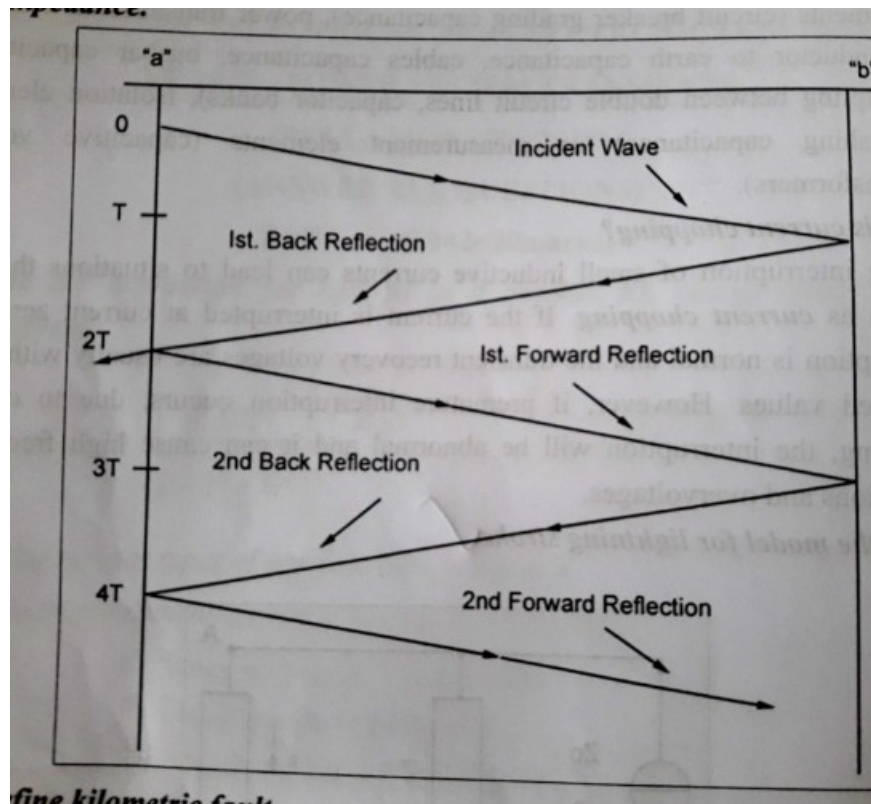
7. What is attenuation? How they are caused?(A/M2017)

The decrease in the magnitude of the wave as it propagates along the line is called attenuation. It is caused due to the energy loss in the line.

8. What are the principles observed in lattice diagram?(N/D2016)

All waves travel down hill (i.e) in to the positive time. The position of the wave at any instant is given by the means of the time scale at the left of the lattice diagram.

9. Draw the neat sketch of Bewley,s Lattice diagram.(M/J2016)



10. What are the damages caused by the travelling waves?(N/D2016)

The high peak (or) crest voltage of the surge may cause Flashover in the internal winding thereby spoiling the windings insulation. The steep wave front of the surge may cause internal flashover between the turns of the transformer.

9. What is travelling wave? What is the role of distributed parameters (R,L ,C) in it.(N/D-2015)

Any disturbance on a transmission line (or) system such as sudden opening or closing of the line, short circuit or s fsult results in the development of over voltages or over current at that point. The disturbance propagate as a travelling wave to the ends of a line or transmission , such as a substation.

11. Define attenuation and distortion. (N.D-2013)

The decrease in the magnitude of The wave at a propagates along the line is called **attenuation**. The elongation or change of wave shape that occurs called **distortion**.

12.What are the principles are observed in Bewley's lattice d iagram.(M/J-2012)

All waves travel down hill (i.e) in to the positive time. The position of the wave at any instant is given by the means of the time scale at the left of the lattice diagram

13.What are the specifications of travelling wave?(A/M-2011)

A travelling wave is characterized by the four specifications Crest of a wave, Front of a wave, Tail of a wave & Polarity.

UNIT-V TRANSIENTS IN INTEGRATED POWER SYSTEM

1. What are the applications of EMTP? (N/D2017)

- The EMTP is a comprehensive computer program designed to solve electrical transient problem in lumpy circuits, distributed circuits.
- This program is capable of solving steady state circuit problems.
- Transient analysis can be carried out in circuits with any arbitrary configuration of lumped parameters. (R,L & C)

2. Define kilometric fault.(or) short line fault (N/D2017,A/M-2013,N/D-2016, A/M-2015, N/D-2015)

Short circuit faults or kilo metric faults occurring on a transmission line length between 0.5 to 5km are termed as short line faults or kilo metric faults. A fault of this type imposes a highly heavy duty on the circuit breaker, there by selecting its interrupting ability.

3. Mention any four causes of switching surge.(A/M2017)

- a) Interruption of low inductive currents by high speed circuit breaker
- b) Interruption of small capacitance current
- c) Ferro resonance
- d) Energization of loaded line

4. Define switching over voltage factor.(A/M-2017)

The peak value of the transient recovery voltage (TRV) can be very high.. In testing and standardization, the damping is expressed by the overvoltage amplitude factor , defined as the ratio between the transient peak value and the steady state value.

5. What are the effects of load rejection in power systems? .(A/M-2017)

Suddenly load rejection on power systems causes the speeding up of generator prime movers. The speed governors and automatic voltage regulates will intervene to restore the normal conditions. Initially both the frequency and voltage increases.

6. What is the effect of switching surges in integrated power system?(M/J-2016)

The disturbance produced by the switching operation is modified by the interconnected system spreads through the system, setting up waves that travel along the lines and reflect to and from the open ends.

7. Distinguish between line dropping and load rejection.(N/D=2016, A/M-2015)_

Voltage drop or line drop in general , on transmission lines the voltage s]simply decreases as one moves from the substation out forward the end of distribution feeder. This change in voltage is known as line dropping.

In real world, load rejection is when there is a fault on the transmission line which is sensed by the` protection system and trip the circuit **breaker concern during that's** time the load connected with the feeder and lines are suddenly dropped (i.E) load throw off or load rejection occurs

8. Write the short notes on EMTP.(M/J 2016)

- The EMTP became popular for the calculation of power system transients especially a switching overvoltage from the viewpoint of insulation design and coordination of a transmission line and a substation in 1996.
- The EMTP development was a part of system analysis computerization including a power/load flow analysis program and a stability analysis program, before the EMTP, a transient network analyzer (TNA) was used. The EMTP was based on the method of travelling wave analysis in a Hydraulic system, well known as a water hammer.

9. Write the network calculation to model a transmission network of EMTP, (N/D-2016)

$[G][V(T)] = [I(T) - [I]]$ Where $[G]$ is the nodal conductance matrix $[V(T)]$ is the node voltages
 $[I(T)]$ is the vector of current sources
 $[I]$ is the vector of past history terms.

10. What are the potential advantages of EMTP?

EMTP is a comprehensive computer program defined to solve:

1. Electrical transient problems in lumpy circuits and distributed circuits
2. Steady- state circuit problems
3. Arbitrary configuration of lumped parameters
4. Distributed parameters, transposed (or) untransposed)

11. Mention the features of EMTP.(N/D-2014)

1. Sophisticated computer program for the simulation electromagnetic Electromechanical and control system transients in multiphase power systems.
2. Advanced model of electrical machines
3. Detailed and precise models of lines and cables
4. Complete model of transformers etc.

12. Which software do you suggested to solve electrical transient Problems? (M/J2014)

EMTP- Electro Magnetic Transient Analysis Program

13. Mention the effects of transients when switch is closed?(N/D-2013)

When a switch is suddenly closed immediately prior to the circuit being completed, certain voltage across the switch contacts. At the moment the contacts made