1. What is the necessity of voltage regulation?
   All equipments in power system are designed to operate satisfactorily only when the voltage level on the system correspond to their rated values. So voltage regulation is very important.

2. What are the disadvantages of voltage regulation?
   The disadvantage of voltage regulation are, i) If voltage variation is more than a pre specified value, the performance of equipments is poor. ii) Life in most of the equipments is also sacrificed.

3. Why the frequency regulation is very important?
   Since the speed of induction motors depend upon the system frequency, regulation of power system frequency is very important.

4. Give some category of load device
   The category of load devices is,

5. How the multitudes of devices are characterized?
   The multitude of devices are characterized by,
   a. Size
   b. Symmetry (single or three- phase)
   c. Load constancy (in respect to time, frequency and voltage)
   d. Use cycle (regular or random use).

6. What are the effects of load dependency on voltage and frequency?
   The effects of load dependency on voltage and frequency are, a. Serious problems are created in HP motors. b. If efficiency and power factor increases, current decreases. c. Generators are lead to shut down.

7. What is load management?
   As generator capacity has increased in price (to as much as $1000 per kilowatt) and as the fuel shortages put an extra squeeze on them, many electric utilities are finding it worthwhile to try to ‘slave’ the load peaks. This is referred to as load management.

8. Give the two major control loops of large generators?
   The two major control loops of large generators are,
   a. Automatic Voltage Regulator (AVR), b. Automatic Load Frequency Control (ALFC)

9. Write about AVR loop.
   The automatic voltage, regulator (AVR) loop controls the magnitude of the terminal voltage V. The latter voltage is continuously sensed, rectified and smoothed. This D.C. signal, the resulting ‘error voltage’, after amplification and signal shaping serves as the input to the exciter which finally delivers the voltage Vf to the generator field winding.

10. How the ALFC loop is affected by AVR loop?
    AVR affect the magnitude of generated emf Eg. This generated emf affects the generated real power. Therefore changes in AVR loop affect ALFC loop.

11. Write about load frequency mechanism.
    The frequency is closely related to the real power balance in the overall network. Under normal operating conditions the system generators run synchronously and generate together the power at each moment is being drawn by all loads plus the real.

12. Give an important reason for voltage control.
    The real line losses depend as much upon the reactive as upon the real line power flow. It is possible to minimize these losses by selecting an optimum power flow, in terms of real and reactive powers. So the voltage control is very important.
13. **What is the one distinct difference between P-f and Q-V control?**

   The surplus of megavars tends to increase the frequency of a system. The changes are not uniform but will be greatest at the buses where the Q surplus is the greatest. This is one distinct difference between P-f and Q-V control.

14. **What is the use of secondary loop?**

   A slower secondary loop maintains the fine adjustment of the frequency, and also by ‘reset’ action maintains proper megawatt interchange with other pool members. This loop is insensitive to rapid load and frequency changes but focuses instead on drift-like changes which take place over periods of minutes.

15. **What is the advantage of AVR loop over ALFC loop?**

   AVR loop is much faster than the ALFD loop and therefore there is a tendency, for the AVR dynamics to settle down before they can make themselves felt in the slower load – frequency control channel.

16. **What is the difference between large signal and small signal analysis?**

   Voltages and powers may undergo sudden changes of magnitude that may approach 100 percent of normal operating values. Usually, this type of analysis leads to differential equations of nonlinear type. Small signal analysis is used when variable excursions are relatively small, typically at most a few percent of normal operating values.

17. **What is the exciter?**

   The exciter is the main component in the AVR loop. It delivers the D.C. power to the generator field. It must have adequate power capacity (in the low megawatt range for large generators) and sufficient speed of response (rise times less than 0.1 seconds).

18. **What is the function of AVR?**

   The basic role of the AVR is to provide constancy of the generator terminal voltage during normal, small and slow changes in the load.

19. **Explain about static AVR loop.**

   In static AVR loop, the excitation power is obtained directly from the generator terminals of from the station service bus. The A.C. power is rectified in thyristor bridges and fed into the main generator field via slip rings. Static exciters are very fast and contribute to improved transient stability.

20. **Write the static performance of the AVR loop.**

   The AVR loop must a. Regulate the terminal voltage [V] to within required static accuracy limit. b. Have sufficient speed of response. C. Be stable.

21. **What is the disadvantage of high loop gain? How is it eliminated?**

   High loop gain is needed for static accuracy but this causes undesirable dynamic response, possibly instability. By adding series and / or feedback stability compensation to the AVR loop, this conflicting situation can be resolved.

22. **What are the effects of generator loading in AVR loop?**

   Added load does not change the basic features of the AVR loop. It will, however, affect the values of both gain factor KF and the field time constant. High loading will make the generator work at higher magnetic saturation levels. This means smaller changes in |E| for increment increases in if translating into a reduction of KF. The field time constant will likewise decrease as generator loading means closing the armature current paths. This circumstance permits the formation of transient stator currents, the existence of which yields a lower effective field inductance.

23. **What are the functions of ALFC?**

   The basic role of ALFC is to maintain desired megawatt output of a generator unit and assist in controlling the frequency of the larger interconnection. The ALFC also helps to keep the net interchange of power between pool members at predetermined values. Control should be applied in such a fashion that highly differing response characteristics of units of various type (hydro, nuclear, fossil, etc.) are recognized. Also, unnecessary power output changes should be kept to a minimum in order to reduce wear of control values.
24. Specify the disadvantages of ALFC loop?
   The ALFC loop will maintain control only during normal (small and slow) changes in load and frequency. It is typically unable to provide adequate control during emergency situations, when large megawatt imbalances occur. Then more drastic ‘emergency’.

25. How is the real power in a power system controlled?
   The real power in a power is being controlled by controlling the drinking torques of the individual turbines of the system.

26. What is the need for very large mechanical forces in speed – governing system?
   Very large mechanical forces are needed to position the main value (or gate) against, the high steam (or water) pressure, and these forces are obtained via several stages of hydraulic amplifiers.

27. What are the inputs of governor?
   The governor has two inputs. They are, a. Changes $\Delta \text{pref}$ in the reference power setting, b. Change $\Delta f$ in the speed of frequency of the generator, as measured by $\Delta xB$.

28. What is the control area?
   Most power systems normally control their generators in unison. The individual control loops have the same regulation parameters. The individual generator turbines tend to have the same response characteristics then it is possible to let the control loop in the whole system which then would be referred to as a control area.

29. Specify the use of static and dynamic response of the ALFC loop.
   The static response of the ALFC loop yielded important information about frequency accuracy. The dynamic response of the loop will inform about ‘tracking’ ability and stability of the loop.

30. What is the basic principle in pool operation?
   A basic guiding principle in pool operation must be that each area, in normal steady state, absorbs its own load.

31. Where is the oscillation detected in Peninsular Florida grid?
   A power system may experience stability problems usually in the form of self-excited low frequency oscillations. In Peninsular Florida grid, the oscillation is detected not only in the system frequency but also in the tie-line which will experience power ‘sloshings’ of increasing magnitude. This type of instability is actually caused by cross-coupling between the AVR and ALFC loops. It is directly associated with the so-called natural oscillatory modes.

32. What is known as brushless excitation?
   Modern the generator excitation system maintains generator voltage and controls the reactive power flow. The generator excitation of older systems may be provided through slip rings and brushes by means of D.C generators mounted on the same shaft as the rotor of the synchronous machine. However, modern excitation systems usually use A.C. generators with rotating rectifiers, and are known as brushless excitation.

33. What are the sources of reactive power? How it is controlled?
   The sources of reactive power are generators, capacitors, and reactors. These are controlled by field excitation.

34. What is the function of exciter?
   Exciter is the main component in the AVR loop. It delivers D.C. Power to the generator field. It must have adequate power capacity and sufficient speed of response.

35. Give some excitation system amplifier.
   The excitation system amplifiers are, a. Magnetic amplifier b. Rotating amplifier, c. Modern electronic amplifier

36. What are the points to be considered in static performance of AVR loop?
   The AVR loop must a. Regulate the terminal voltage accuracy limit. b. Have sufficient speed of response.
37. When is feedback stability compensation used?
   High loop gain is needed for static accuracy but this causes undesirable dynamic response, possibly instability. This conflicting situation is resolved by adding feedback stabilizing compensation to the AVR loop.

38. Give the characteristics of line compensators.
   The characteristics of line compensators are, a. Ferranti effect is minimized. b. Under excited operation of synchronous generators is now required.

39. What is known as line compensation?
   The power transfer capability is enhanced. Modifying the characteristics of the line is known as line compensation.

40. List the various compensating devices.
   The various compensating devices are, a. Capacitors, b. Capacitors and inductors, c. Active voltage source (synchronous generator).

41. What is known as bank of capacitors? How it is adjusted?
   When a number of capacitors are connected in parallel to get the desired capacitance, it is known as bank of capacitors. These can be adjusted in steps by switching (mechanical).

42. What is active compensation?
   When solid-state devices are used for switching off capacitors and inductors, this is regarded as active compensation.

43. Give the types of critical loadings in transmission lines.
   A transmission line has three critical loadings. They are a. Natural loading, b. Steady state stability limit c. Thermal limit loading.

44. What are the disadvantages of switched capacitors are employed for compensation?
   When switched capacitors are employed for compensation, these should be avoiding excessive voltage rise and Ferro resonance in presence of transformers.

45. Mention the purposes of series compensation.
   The purposes of series compensation are. a. Increase of maximum power transfer. b. Reduction in power angle for a given amount of power transfer. c. Increased loading.

46. What are the effects of capacitor in series compensation circuit?
   The effects of capacitor in series compensation circuit are, a. Voltage drop in the line reduces b. Prevents voltage collapse, c. Steady-state power transfer increases d. Transient stability limit increases.

47. Write the expression of effective reactance in series compensation.
   The effective reactance is given by, \( XL = X - Xc \), Where, \( XL = \) Line reactance, \( XC = \) Capacitor reactance.

48. Give the two kinds of capacitors used in shunt compensator.
   The two kinds of capacitors used in shunt compensator are, a. Static var compensator (SVC) : These are banks of capacitors(Sometimes inductors also for use under light load conditions).

49. What is synchronous condenser?
   It is synchronous motor running at no-load and having excitation adjustable over a wide range. It feeds positive VARs into line under overexcited conditions and negative VARs when under excited.

50. Write about static VAR compensator (SVC).
   These comprise capacitor bank fixed or switched or fixed capacitor bank and switched reactor bank in parallel. These compensators draw reactive (loading or lagging) power from the line thereby regulating voltage, improves stability (steady-state and dynamic), control over voltage and reduce voltage and current unbalances. In HVDC application these compensators provide the required reactive power and damp out sub harmonic oscillation.
51. What is called static Var switches or systems?
Static var compensators use switching for var control. These are also called static var switches or systems. It means that terminology wise SVC=SVS And we will use these interchangeably.

52. Give some of the static compensators schemes.
Some of the static compensators schemes are, a. Saturated reactor, b. Thyristor-Controlled Reactor (TCR), c. Thyristor switched capacitor (TSC), d. Combined TCR and TSC compensator

53. What is saturated reactor?
This is a multi core reactor with the phase windings so a constant voltage reactive source. It is almost maintenance free but not very flexible with respect to operating characteristics.

54. How the TSCs are characterized?
TSCs are characterized by step wise control, no transients, very low harmonics, low losses, redundancy and flexibility.

55. List the advantages of series compensation.
The advantages of series compensation are,
   a. Series capacitors are inherently self-regulating and a control system is not required.
   b. For voltage stability, series capacitors lower the critical
   c. Series capacitors possess adequate time-overload capability.
   d. For the same performance, series capacitors are often less costly than SVCs and losses are very low.

56. Write the applications of synchronous condenser.
The applications of synchronous condensers are,
   a. It is better than SVCs in voltage-weak networks.
   b. A drop in network voltage, the increase in condenser reactive power output is instantaneous.
   c. It is used in HVDC installations.

57. Write the two types of VAR generators.
The two types of VAR generator are, a. Static VAR generator, b. Rotating VAR generator

58. Give some observations of rotating VAR generators.
The following observations can be made for rotating VAR generators
   a. These can provide both positive and negative VARs which are continuously adjustable.
   b. VAR injection at a given excitation is less sensitive to changes in bus voltage.

59. What is tap changing transformers?
All power transformers and many distribution transformers have taps in one or more windings for changing the turns ratio. It is called tap changing transformers. This method is the most for controlling voltages at all levels.

60. Write the types of tap changing transformers.
The types of tap changing transformers are, a. Off-load tap changing transformers, b. Tab changing under load (TCUL) transformers.

61. What is the use of off-load tap changer and TUCL?
The off-load tap changers are used when it is expected that the ratio will need to be changed only infrequently, because of load growth or some seasonal change. TCUL is used when changes in ratio may be frequent or when it is undesirable to de-energize the transformer to change a tap.

62. List some important control system functions.
Some of the control system functions are, EMS - Energy Management System. It exercises overall control over the total system. SCADA - Supervisory Control and Data Acquisition System-It converts generation and transmission system. DAC – Distribution
Automation and Control System. It oversees the distribution system including connected loads.

63. **What is meant by SCADA?**

SCADA refers to a system that enables an electricity utility to remotely monitor, coordinate, control and operate transmission and distribution. Components, equipment and devices in a real time mode from a remote location with acquisition of data for analysis and planning from one control location.

64. **Write the non-critical functions of SCADA system.**

The non-critical functions of SCADA system are,

a. Recording of the load.

b. Forecasting of load.

c. Unit starts -ups and shutdowns are carried out on an hourly basis.

65. **What is DAC?**

DAC is a lower level version of SCADA applicable in distribution system (including loads), which of course draws power from the transmission / sub transmission levels obviously then there is no.

66. **What is the use of computerization in distribution network?**

In distribution network, computerization can help manage load, maintain quality, detect theft and tampering and thus reduce system losses. Computerization also helps in centralization of data collection.

67. **What are the uses of distribution automation through SCADA systems?**

Distribution automation through SCADA systems directly leads to increased reliability of power for consumers and lower operating costs for the utility. It results in forecasting accurate demand and supply management, faster restoration of power in case of a failure and alternative routing of power in an emergency.

68. **What is the function of Data Acquisition System (DAS)?**

Data Acquisition System provides a supporting role to the application software in a control center. This system collects raw data from selected points in the power system and converts these data into engineering units.

69. **Write about man-machine interface.**

The man-machine interface provides a link between the operator and the software / hardware used to control/ monitors the power system. The interfere generally is a color graphic display system. The control processors interface with the control interface of the display system.

70. **What are the advantages of computer control?**

The advantages of computer control are,

a. Increase in capacity utilization in generation.

b. Savings in energy and so in raw materials due to increased operational efficiency.

c. Flexibility and modifiability.

d. Reduction in human drudgery.

e. Improved operator effectiveness.

71. **Give the new functional concepts of Artificial Intelligence (AI).**

New functional concepts from the field of artificial intelligence (AI) will be integrated with power system monitoring, automatic restoration of power networks, and real-time control.

72. **Give the three major functions of system security.**

The three major functions of system security are,

a. System monitoring.

b. Contingency analysis.

c. Security-constrained optimal power flow.

73. **What are the processes involved in contingency analysis?**

Several variations of this type of contingency is scheme involve fast solution methods, automatic contingency event selection, and automatic initializing of the contingency power flows using actual system data and state estimate procedures.

74. **Mention the four operating states of power system.**

The four operating states of power system are,

a. Optimal dispatch

b. Post contingency

c. Secure dispatch

d. Secure post-
75. What is optimal dispatch?
Optimal dispatch is the state that the power system is in prior to any contingency. It is optimal with respect to economic operation, but it may not be secure.

76. What is post contingency?
Post contingency is the state of the power system after a contingency has occurred. We shall assume here that this condition has a security violation (line or transformer beyond its flow limit, or a bus voltage outside the limit.)

77. What is called SCOPF?
Programs which can make control adjustments to the base or pre-contingency operation to prevent violations in the post-contingency conditions are called ‘security-constrained optimal power flows’ or SCOPF.

78. What are the priorities evolved in modern power systems?
The priorities of modern power systems are, a. Operate the system in such a way that power is delivered reliably, b. Within the constraints placed on the system operation by reliability considerations, the system will be operated most economically.

79. What is equality and inequality?
Equality (E) means that the total system generation equals total system load. Inequality (I) refers to currents and voltages being kept within rated limits.

80. What are the types of constraints?
The constraint functions and simple variable limits will be lumped under the term called constraints. The types of constraints are, a. Equality constraints, b. Inequality constraints i. Hard type ii. Soft type

81. What is binding and non-binding?
When an optimum solution to a constrained optimization problem occurs at the boundary of the feasible region defined by a constraint is building. If the optimum solution lies away from the boundary, the constraint is non-binding.

82. Define incremental fuel rate.
Incremental fuel rate is a ratio equal to a small change in input to the corresponding small change in output.

83. Define incremental efficiency.
Incremental efficiency is defined as the reciprocal of incremental production cost or incremental fuel rate. Incremental efficiency = Output = dP Input dF

84. How the formula of transmission loss in terms of generation is derived?
Transmission loss formula is derived under the following assumptions. a. The equivalent load current at any bus remains a constant complex fraction of the total equivalent load current. b. The generator bus voltage magnitudes and angles are constant. c. The power factor of each source is constant.

85. What are the two assumptions for deriving the loss coefficients?
The two assumptions for deriving the loss coefficients are, a. The ration X/R for all the transmission lines is the same. b. The phase angle of all the load currents is the same.

86. Define incremental loss.
The incremental loss dPLj, n/dPj is defined as the ratio of change in loss to the change in generation at plant j when power is transferred from plant j to plant n, with the generations of other plants and load keeping fixed.

86. Give the components of automatic load dispatching.
The components of automatic load dispatching are, a. Computer, b. Data input, c. Console, d. Machine controllers

86. What is the use of Power Line Carrier Communication (PLCC)?
The term power line carrier is used to represent the entire process of communication
which uses high voltage overhead power lines as the means of transmission

87. Give the two forms of stopping rules in iterative procedure.
   The two general forms of stopping rules are,
   a. First rule based on finding the proper operating point within a specified tolerance.
   b. Second rule involves counting the number of times through the iterative loop and
      stopping when a maximum number is exceeded.

88. What is the use of Newton- Raphson method?
   Newton – Raphson method is used to project the incremental cost value to derive the
   error between the computed and desired generation to zero.

89. What is the function of Dynamic Programming (DP) in economic dispatch?
   DP approach does not calculate a single optimum set of generator MW outputs for a
   specific total load supplied rather a set of outputs are generated, at discrete points, for an entire
   set of load values.

90. Why the DP techniques in scheduling of power generation system are developed?
   The DP techniques in scheduling of power systems are developed for the following. a.
   The economic dispatch of thermal systems. b. The solution of hydrothermal economic –
   scheduling problems. c. The practical solution of the unit commitment problem.

91. What is unit commitment problem?
   Optimization problem demonstrates the complexity involved when we must commit
   (turn on) generating units, as well as dispatch them economically. This problem is known as the
   unit commitment problem.

92. What is parallel frequency regulation?
   The possibility of sharing the change in load is that both S1 and S2 would regulate their
   generations to maintain the frequency constant. This is known as parallel frequency regulation.

93. Mention the two types of automatic arrangements.
   The two types of automatic arrangements are, a. Selective frequency control b. Tie-
   line load-bias control

94. What is selective frequency control?
   The common method of operating a large interconnected system assigns frequency
   control to a central system, the other systems then controlled on the basis of automatic control
   are used in three different ways. One of these is known as selected frequency control.

95. What are the parts of speed governing system?
   The parts of speed governing system are, a. Speed governor, b. Linkage mechanism
   c. Hydraulic amplifier, d. Speed changer

96. Write about speed governor and speed changer.
   Speed governor is a fly-ball type of speed governor and constitutes the heart of the
   system as it senses the change in speed or frequency with the increase in speed the fly-ball
   move outwards and the linkage mechanism move downwards. The speed changer provides a
   steady state power output setting for the turbine. The downward movement of the speed
   changer opens the upper pilot valve so that more steam is admitted to the turbine under steady
   condition. The reverse happens when the speed changer moves upward.

97. Write about hydraulic amplifier.
   Hydraulic amplifier consists of a main piston and pilot valve. Low power level pilot
   valve movement is converted into high power level piston valve movement which is
   necessary to open or close the steam valve against high pressure steam.

98. Give some reasons for limits on frequency.
   The reasons for limits on frequency are, a. The electric clocks are driven by synchronous motors and the accuracy at these clocks is not only a function of frequency error but is actually of the integral of this error. b. The system operation at subnormal frequency and voltage leads to loss of revenue to the suppliers due to accompanying reduction in load demand.
99. How the single area controlled system is protected?
   The single area controlled system is protected by the following three ways, a. ‘Borrowed’ kinetic energy from the rotating machines of the system. b. ‘Released’ customer load. c. Increased generation.

100. What is damping factor?
   Damping factor is known as frequency co-efficient of load and characterizes the frequency characteristic of the load. It is usually expressed in percent of connected load per 0.1 Hz and the typical values lie between 0.3 to 0.5% per 0.1 Hz. It is denoted as $D = \frac{dPD}{df}$

101. Define economic dispatch problem?
   The objective of economic dispatch problem is to minimize the operating cost of active power generation.

102. Define incremental cost?
   The rate of change of fuel cost with active power generation is called incremental cost.

103. Write the load balance equation.
   $P_g - P_d - P_L = 0$

104. Define base point?
   The present operating point of the system is called base point.

105. Define participation factor?
   The change in generation required to meet the power demand is called participation factor.

106. Define hydrothermal scheduling problem?
   The objective is to minimize the thermal generation cost with the constraints of water availability.

107. Define unit commitment?
   Commitment of minimum generator to meet the required demand.

108. Define spinning reserve?
   It is the term describes the total amount of generation availability from all units synchronized on the system.

109. What is meant by scheduled reserve?
   These include quick start diesel turbine units as well as most hydro units and pumped storage hydro units that can be brought on line, synchronized and brought up to full capacity quickly.

110. What are the thermal unit constraints?
    Minimum up time, Minimum down time, Crew constraints

111. Define min. up time?
    Once the unit is running, it should not be turned off immediately.

112. Define min. down time?
    Once the unit is decommitted, there is a minimum time before it can be recommitted.

113. Define crew constraints?
    If a plant consists of two or more units, they cannot both be turned on at the same time since there are not enough crew members to attend both units while starting up.

114. What are the two approaches to treat a thermal unit to operating temperature?
    The first allows the unit boiler to cool down and then heat back up to operating temperature in time for a scheduled turn on. The second requires that sufficient energy be input to the boiler to just maintain operating temperature.

115. What are the techniques for the solution of the unit commitment problem?
116. What are the assumptions made in dynamic programming problem?
   A state consists of an array of units with specified units operating and the rest of the time. The start up cost of a unit is independent of the time it has been off line, there are no costs for shutting down a unit.

117. Define long range hydro scheduling problem?
   The problem involves the long range forecasting of water availability and the scheduling of reservoir water releases. For an interval of time that depends on the reservoir capacities.

118. What are the optimization techniques for long range hydro scheduling problem?
   Dynamic programming, Composite hydraulic simulation methods, Statistical production cost.

119. Define short range hydro scheduling problem?
   It involves the hour by hour scheduling of all generators on a system to achieve min production cost for the given time period.

120. Define system black out?
   If any event occurs on a system that leaves it operating with limits violated, the event may be followed by a series of further actions that switch other equipment out of service. If the process of cascading failures continues, the entire system of it may completely collapse. This is referred as system black out.

121. What is meant by cascading outages?
   If one of the remaining lines is now too heavily loaded, it may open due to relay action, thereby causing even more load on the remaining lines. This type of process is often termed as cascading outage.

122. What are the functions of control center?
   System monitoring, Contingency analysis, Security constrained optimal power flow.

123. What is the function of system monitoring?
   System monitoring provides up to date information about the power system.

124. Define SCADA system?
   It stands for supervisory control and data acquisition system it allows a few operators to monitor the generation and high voltage transmission systems and to take action to correct overloads.

125. What are the states of power system?
   Normal state, Alert mode, Contingency mode, Emergency mode

126. Define normal mode?
   The system is in secure even the occurrence of all possible outages has been simulated the system remains secure is called normal mode.

127. Define alert mode?
   The occurrence of all possible outages the system does not remain in secure is called alert mode.

128. What are the distribution factors?
   Line outage distribution factor, Generation outage distribution factor

129. Define state estimation?
   State estimation is the process of assigning a value to an unknown system state variable based on measurements from that system according to some criteria.

130. Define max. Likelihood criterion?
   The objective is to maximize the probability that the estimate of the state variable, x, is the true value of the state variable vector (i.e., to maximize the P(x)=x).
131. Define weighted least-squares criterion?
The objective is to minimize the sum of the squares of the weighted deviations of the estimated measurements, $z$, from the actual measurements, $z$.

132. Define minimum variance criterion?
The objective is to minimize the expected value of the squares of the deviations of the estimated components of the state variable vector from the corresponding components of the true state variable vector.

133. Define must run constraint?
Some units are given a must run status during certain times of the year for reasons of voltage support on the transmission network.

134. Define fuel constraints?
A system in which some units have limited fuel or else have constraints that require them to burn a specified amount of fuel in a given time.

135. What are the assumptions made in priority list method?
- No load cost is zero; Unit input-output characteristics are linear between zero output and full load. There are no other restrictions.
- Start up cost is a fixed amount.

136. State the advantages of forward DP approach?
If the start up cost of a unit is a function of the time it has been off line, then a forward dynamic program approach is more suitable since the previous history of the unit can be computed at each stage.

137. State the disadvantages of dynamic programming method?
It has the necessity of forcing the dynamic programming solution to search over a small number of commitment states to reduce the number of combinations that must be tested in each period.

138. Define short range hydro scheduling problem?
Short range hydro scheduling involves the hour by hour scheduling of all generation on a system to achieve minimum production cost for the given time period.

139. What are the known values in short term hydro scheduling problem?
The load, hydraulic inflows, and unit availabilities are assumed known.

140. What is meant by telemetry system?
The states of the system were measured and transmitted to a control center by means of telemetry system.

141. What are the functions of security constraints optimal power flow?
In this function, contingency analysis is combined with an optimal power flow which seeks to make changes to the optimal dispatch of generation. As well as other adjustments, so that when a security analysis is run, no contingency result in violations.

142. Define the state of optimal dispatch?
This is the state that the power system is in prior to any contingency, it is optimal with respect to economic operation, but it may not be secure.

143. Define post contingency?
This is the state of the power system after a contingency has occurred.

144. Define secure dispatch?
This is the state of the power system with no contingency outages, but with corrections to the operating parameters to account for security violations.

145. Define post contingency?
It is the state of the system when the contingency is applied to the base operating condition with corrections.

146. What are the priorities for operation of modern power systems?
Operate the system in such a way that power is delivered reliably.
Within the constraints placed on the system operation by reliability considerations, the system will be operated most economically.

147. **What is meant by linear sensitivity factor?**
   Many outages become very difficult to solve if it is desired to present the results quickly. Easiest way to provide quick calculation of possible overloads is linear sensitivity factors.

148. **What are the linear sensitivity factors?**
   Generation shift factors, Line outage distribution factors

149. **What are the uses of line outage distribution factor?**
   It is used to apply to the testing for overloads when transmission circuits are lost.

150. **What is meant by external equivalencing?**
   In order to simplify the calculations and memory storage the system is sub divided in to 3 sub systems is called external equivalencing.

151. **What is meant by fly ball speed governor?**
   It is purely mechanical speed sensitive device coupled directly to the hydraulic amplifier which adjusts the control valve opening via the linkage mechanism.

152. **Define load and list out types of load.**
   Load is a device that taps energy from the network. a) Lightning and heating load, b) Induction motors, & c) Electronic devices.

153. **Draw the ideal speed droop characteristics of a speed governor.**

154. **How does power transfer occur in power system?**

155. **What are the advantages of pool operation with respect to LFC?**
   i) 50% of the added load in area 2 will be supplied by area 1 through the tie line.
   ii) Frequency droop will be only half compared with that of single area.

156. **What is speed governor?**
   It comprises of the elements which are directly responsive to speed and whose positions influence the action of the other elements of speed governing system.

157. **Define Per unit speed regulation.**
   The per unit droop or speed regulation $R$ of the generating unit is defined as the magnitude of the change in steady-state speed, expressed in p.u of rated speed when the output of the unit is gradually reduced from 1.0 p.u rated power to zero. $R_{p.u} = \frac{(f_2 - f_1)}{f_0 P_{r}}$ p.u.

158. **What is percent speed regulation or droop?**
   \[ R = \frac{\omega_N - \omega_F}{\omega_N} \times 100 \]
   $\omega_N$ = steady-state speed at no load
   $\omega_F$ = steady-state speed at full load
   $\omega_N$ = nominal or rated speed

159. **Define speed governing system.**
   This includes the speed – governor, speed –control mechanism, governor-controlled valves and speed changer.

160. **Define speed changer.**
It is a device by means of which the speed governing system may be adjusted to change the speed or power output of the turbine.

161. **Define governor controlled valves.**
This includes those valves that control the input to the turbine, and that are normally actuated by the speed governor with the help of speed-control mechanism.

162. **What are conditions for proper synchronizing?**

163. **Differentiate primary and supplementary control.**

164. **Why the frequency and voltage to be regulated in a power system?**

165. **What are the various functions of excitation system?**
   i) To provide DC excitation to alternator, ii) vary the field current in order to control generated voltage, iii) control of voltage and reactive power flow and enhancement of system stability and iv) protective functions ensures that the capability limits of machine, excitation system and other equipments are not exceed.

166. **What is called as stiffness of the system?**

Composite frequency response characteristics of the system is
\[ \beta = -\frac{\Delta P_L}{\Delta f_{ss}} = \frac{1}{R_e} + D, \]
the composite regulation characteristics of the system is \( 1/\beta \).

**16 marks questions**

**PART – B**

1. Explain the need for voltage and frequency regulation in power system. (16)

2. What are the components of speed governor system of an alternator? Derive a transfer function and sketch a block diagram. (16)

3. Draw and explain the basic P-f and Q-V control loops. (16)

4. Briefly explain about the plant level and the system level controls. (16)

5. Briefly discuss the classification of loads and list out the important characteristics of various types of loads. (16)

6. i) Briefly explain the overview of system operation. (8)
ii) Explain about the Static characteristics of various loads (8)

7. Write a detailed technical note on the operating problems in power systems.

8. Short notes on the following
   a. Generator response to load change
   b. Load response to frequency deviation.

9. Explain the speed droop characteristics of governor.

10. Explain Transfer of power between active sources

**UNIT II - FREQUENCY CONTROL AND AUTOMATIC GENERATION CONTROL**

**PART – B**

1. Discuss in detail the dynamic response of a single area system, without integral control, following a step load disturbance. (16)

2. Derive the transfer function of an uncontrolled load frequency control of a single area system and derive the expression for static error following a step load change. (16)

3. Draw the transfer function block diagram for a two area system provided with governor control and obtain the steady state frequency error following a step load change in both the areas. (16)

4. A 210 MVA, 50 Hz Turbo Alternator operates at no load at 3000 rpm. A load of 75 MW is suddenly applied to the machine and the steam valves to the turbine commence to open after 1 sec due to the time lag in the governor system. Assuming Inertia Constant H of 5Kw-sec
5. The data pertaining to a single area power system with linear load-frequency characteristics are as follows:
- Rated Capacity = 2000 MW
- System Load = 1000 MW
- Inertia Constant = 5 sec
- Speed regulation = 0.03 pu
- Load damping factor = 1 pu
- Nominal Frequency = 50 Hz
- Governor Time constant = 0 sec
- Turbine time constant = 0 sec

For a sudden change in load of 20 MW, determine the steady state frequency deviation and the change in generation in MW and reduction in original load in MW.

6. The data pertaining to a single area power system with linear load-frequency characteristics are as follows:
- Rated Capacity = 1200 MW
- System Load = 600 MW
- Inertia Constant = 4 sec
- Speed regulation = 4% Load damping factor = 0.85 pu
- Nominal Frequency = 50 Hz
- Governor Time constant = 0.06 sec
- Turbine time constant = 0.3 sec

For a sudden change in load of 40 MW, determine the steady state frequency deviation.

7. A two area power system has two identical areas with parameters are given below:
- Rated Capacity of the area = 3000 MW
- Nominal Operating load = 1500 MW
- Inertia Constant = 4 sec
- Speed regulation = 4%
- Load damping factor = 1 pu
- Nominal Frequency = 50 Hz
- Governor Time constant = 0.06 sec
- Turbine time constant = 0.3 sec

A load increase M2 = 30 MW, occurs in area 2. Determine
i) the steady state frequency deviation
ii) \( \Delta P_{12s} \)

8. A two area system connected by a tie-line has the following parameters:

<table>
<thead>
<tr>
<th>AREA</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine output Power (MW) Nominal</td>
<td>4000</td>
<td>2000</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Inertia Constant speed regulation</td>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>Power system Gain ( kp) Governor</td>
<td>50</td>
<td>125</td>
</tr>
<tr>
<td>Time Constant</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>Turbine Time Constant</td>
<td>0.3</td>
<td>0.25</td>
</tr>
</tbody>
</table>

A load change of 80 MW occurs in area 1. Determine the steady state frequency and the change in the tie-line flow.

UNIT III – REACTIVE POWER AND VOLTAGE CONTROL

PART – B
1. i) Discuss generation and absorption of Reactive Power
ii) Explain how voltage control can be affected by injection of Reactive Power

3. Explain different types of static VAR compensators with a phasor diagram

5. The load at receiving end of a 3Φ overhead line is 30 MW, 0.8 pf lag at the line voltage of 66kV. A synchronous compensator is situated at sending end and the voltage at both ends of the line is maintained at 66kV. Calculate the MVAR of compensator. The line has a resistance and reactance of 6Ω/ph, 24 Ω/ph, respectively.

6. A 415 kV line is fed through an 132/415kV transformer from a constant 132kV supply. At the load end of the line, the voltage is reduced by another transformer of ratio 415/132kV. The total impedance of the line is \((30+j60)\Omega\). Both transformers are equipped with tap-changing, the product of the two off-nominal setting is unity. If the load on the system is 200 MW at 0.8 of lagging. Calculate the settings of the tap-changer required to maintain the voltage at 132kV.
7. Two sub-station are connected by two lines in parallel with negligible impedance, but each containing a tap-changing transformer of reactance 0.22pu on the basis of its rating of 200 MVA. Find the net absorption of reactive power when the transformer, taps are set to 1:1.08, and 1:0.95 respectively. Assume pu voltages to be equal at the two ends.   (16)

UNIT IV - ECONOMIC OPERATION OF POWER SYSTEMS
PART – B
1. i) Explain briefly the constraints on unit commitment problem. (8)
ii) What is spinning reserve and does this reserve help in operating a power system efficiently? (8)

2. Explain Priority list method using full load average production cost. State the merits and demerits. (16)

3. Explain with a neat flowchart the procedure for finding the solution for unit commitment problems using forward DP method. (16)

4. There are three thermal generating units which can be committed to take the system load. The fuel cost data and generation operating unit data are given below:

\[ F_1 = 392.7 + 5.544 P_1 + 0.001093 P_1^2 \]
\[ F_2 = 217 + 5.495 P_2 + 0.001358 P_2^2 \]
\[ F_3 = 65.5 + 6.695 P_3 + 0.004049 P_3^2 , P_1, P_2, P_3 \text{ in MW} \]

Generation limits: 
- \[ 150 \leq P_1 \leq 600 \text{ MW} \]
- \[ 100 \leq P_2 \leq 400 \text{ MW} \]
- \[ 50 \leq P_3 \leq 200 \text{ MW} \]

There are no other constraints on system operation. Obtain an optimum unit commitment table. Adopt Brute force enumeration technique. Show the details of economic schedule and the component and total costs of operation for each feasible combination of units for the load level of 900 MW.

5. The input–output curve characteristics of three units are:

\[ F_1 = 750 + 6.49 P G_1 + 0.0035 P G_1^2 \]
\[ F_2 = 870 + 5.75 P G_2 + 0.0015 P G_2^2 \]
\[ F_3 = 620 + 8.56 P G_3 + 0.001 P G_3^2 \]
The fuel cost of unit 1, 2, 3 is 1.0 Rs / Mbtu. Total load is 800 MW. Use participation factor method to calculate the dispatch for a load is increased to 880 MW? (16)

6. Obtain the priority list of unit commitment using full load average production cost for the given data for the load level of 900 MW.

\[ F_1 = 392.7 + 5.544 P_1 + 0.001093 P_1^2 \]
\[ F_2 = 217 + 5.495 P_2 + 0.001358 P_2^2 \]
\[ F_3 = 65.5 + 6.695 P_3 + 0.004049 P_3^2 , P_1, P_2, P_3 \text{ in MW} \]

Generation limits: 
- \[ 150 \leq P_1 \leq 600 \text{ MW} \]
- \[ 100 \leq P_2 \leq 400 \text{ MW} \]
- \[ 50 \leq P_3 \leq 200 \text{ MW} \]

There are no other constraints on system operation. Obtain an optimum unit commitment table. (16)

7. Derive the expression for base point and participation method. (16)

8. Give iteration algorithm for solving economic scheduling problem, without transmission loss. (16)

9. Derive coordination equation for economic dispatch including losses, in the power system. Give steps for economic dispatch calculation. Neglecting losses (16)

10. Consider the following three units:

\[ IC_1 = 7.92 + 0.003124 P G_1 \]
\[ IC_2 = 7.85 + 0.00388 P G_2 \]
\[ IC_3 = 7.97 + 0.00964 P G_3 \]

PD = 850 MW

PG1 = 392.2 MW, PG2 = 334.6 MW, PG3 = 122.2 MW

Determine the optimum schedule if the load is increased to 900 MW by using Participation Factor method.(16)

UNIT V - CONTROL CENTERS AND POWER SYSTEM SECURITY

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PART – B
1. Explain the different system operating states. (16)
2. Discuss about automatic substation control using SCADA. (16)
3. Explain about SCADA configuration. (16)
4. Briefly discuss the various functions of energy control centre. (16)
5. Explain the hardware components and functional aspects of SCADA system using a fundamental block diagram. (16)
6. Explain the various controls for secure operation. (16)
7. Explain briefly how the system states are continuously monitored and controlled (16)

1. Explain the methods availability for providing economic operation of power system
2. Write short notes on load curve load duration curve energy curve
3. Explain about spinning reserve, hot reserve, cold reserve
4. Explain the solution for solving priority list method by dynamic programming method.
5. Explain about load forecasting and weather sensitive load model
6. Explain the static state estimation of power system.
7. Explain the algorithm for system when operating non steady state condition.
8. How to detect and identify the bad data?
9. Derive the equation for loss coefficients
10. Explain about base point and participation factors?
11. Explain the solution technique for solving hydro thermal scheduling problem?
12. Explain the operating states of power system?
13. Explain the preventive action taken for emergency and restorative control?
14. Write short notes on long range hydro scheduling problem short range hydro scheduling problem
15. Explain the mathematical tech. For hydro thermal scheduling problem?
16. Explain about system equivalency.