Short answer questions

1. True or false? (Circle one)

   1) In NERC’s reliability standards, power system events resulting in the loss of two elements belong to the Category B contingencies.
      True       False

   2) A bulk power system whose generation capacity is 20% more than its peak load may still have reliability problems.
      True       False

   3) Loss of a 500MW generating unit in TVA system may be considered a small disturbance by some system operators in the Eastern Interconnection.
      True       False

   4) A synchronous generator whose exciter adopts a smaller gain $K_d$ must have worse voltage performance but better rotor angle stability.
      True       False

   5) Unlike an SVC or STATCOM, the excitation system of a generator can only control the voltage at its terminal bus.
      True       False

   6) Once stalled under low voltage conditions, an air-conditioner compressor motor behaves more like a constant impedance load.
      True       False

2. Which is the largest NERC interconnection in terms of the system load?
   1) Western    2) Eastern    3) Quebec    4) ERCOT

3. Name one NERC reliability coordinator that is not an RTO or ISO.
   PEAK, TVA

4. For a salient-pole synchronous machine, circle the correct
   1) $E_r < E_q < E'$  2) $L_d > L'_d > L''_d$  3) $\tau_A > \tau_G$  (time constants in AVR)

5. Four Power System Stabilizers respectively adopting the following phase compensators. Circle the one most likely to improve damping for an oscillation mode at 1Hz?
   1) $\frac{1 + 0.4s}{1 + 0.04s}$  2) $\frac{1 + 0.5s}{1 + 2.0s}$  3) $\frac{1 + 0.05s}{1 + s}$  4) $\frac{1 + 2s}{1 + 0.2s}$
About the oscillatory rotor angle shown in the figure,
1) Its natural frequency must be faster than its actual oscillation frequency.
   True  False

2) Damping ratio is higher than 5%.
   True  False

3) It is more likely a zero-state response.
   True  False

2. Power system operators do not want any oscillations. However, it is better to have high frequency oscillations than low frequency oscillations.
   True  False

3. For a synchronous generator connected with an infinite bus by two parallel transmission lines, which will decrease its electromechanical oscillation frequency?
   1) Open one transmission line
   2) Decrease the mechanical power output of the generator
   3) Add a shunt capacitor at the terminal bus of the generator

4. For a linearized power system model $\Delta x = A\Delta x + B\Delta u$,
   1) If $A$ has four eigenvalues, it must have two oscillatory modes
      True  False
   2) The $i^{th}$ left eigenvector of the Jacobian matrix $A$ gives the relative activities of state variables when the $i^{th}$ mode is excited.
      True  False

5. The dominant oscillation path and center of an inter-area mode may change with the operating condition.
   True  False

6. Use a measurement-based method to monitor small-signal stability of a two-area system. If two PMUs located respectively in two areas both detect 0.7Hz oscillations having a phase difference close to 180°, then there must be a 0.7Hz inter-area mode between the two areas.
   True  False

7. To enhance small-signal stability of a power system, the input signal of the supplementary control with an SVC should have a big controllability factor about the concerned oscillatory mode.
   True  False
1. As shown by the power angle cure, the generator of an SMIB system experiences a step change in its mechanical power from $P_{m0}$ to $P_{m1}$, which causes the generator state to move from $a \rightarrow b \rightarrow c \rightarrow b \rightarrow \ldots$. Circle the correct statement(s)

1) Area $A_1$ must be equal to Area $A_2$.
   - True
   - False

2) The generator reaches its maximum speed at point $b$.
   - True
   - False

3) The generator reaches its minimum speed at point $b$.
   - True
   - False

4) If damping of the system is ignored, circle the one equal to the post-disturbance transient stability margin.

\[
\int_{\delta_0}^{\delta_k} (P_{m1} - P_e) d\delta \quad \int_{\delta_k}^{\delta_{L}} (P_e - P_{m1}) d\delta \quad \int_{\delta_{L}}^{\delta_{max}} (P_{m1} - P_e) d\delta \quad \int_{\delta_{max}}^{\delta_{L}} (P_e - P_{m1}) d\delta
\]

2. When the Trapezoidal rule method is used to simulate a power system modeled by $\dot{x} = f(x,t)$,

1) At time step $t = t_n$, the accuracy of simulation is not affected for dynamic modes slower than $f(x_n,t_n)$.
   - True
   - False

2) The stiffness of the system does not affects numerical stability.
   - True
   - False

3. Consider a power system losing transient stability under a fault, the Exit Point where the system state escapes from the stability region must be an Unstable Equilibrium Point of the post-fault system.
   - True
   - False

4. In the overall differential-algebraic equation model for simulation of a power system, differential equations are necessary only for generators and associated controllers such as governors, exciters and PSS.
   - True
   - False
5. Consider the two-area system having four identical synchronous machines. Which of the following can necessarily improve the transient stability of the system against a temporary short-circuit fault on bus 7 lasting for 5 cycles?

1) Adding a STATCOM to bus 8 with a voltage setting point of 1.0 p.u.
2) Adding a PSS to generator G1 that is well-tuned for its local oscillation mode
3) Outage of G1 for maintenance under the same system load
4) Increase the inertia of G1 by 20% and decrease the inertia of G3 by 20%
5) Make the two loads at buses 7 and 9 be 100% constant power loads

6. For the above two-area system, assume that we adopt a TEF that is equal to the sum of the kinetic and potential energies of four individual machines with respect to the center of inertia (COI) of the system, i.e.

\[ V = \frac{1}{2} \sum_{i=1}^{4} J_i \omega_i^2 - \sum_{i=1}^{4} P_{mi}'(\theta_i' \cdot \theta_i) \]

If the calculated stability margin in terms of this TEF is positive for the system state right after a fault is cleared, the system will be first-swing stable.

True   False
1. In an AC line, reactive power is always transmitted from the high voltage side to the low voltage side.
   - True   False

2. Since under-voltage load shedding (UVLS) performed by electricity utilities is activated by detection of abnormal voltage levels, the degree of voltage stability can be judged based only on how close a bus voltage is to the normal voltage level.
   - True   False

3. Consider a load bus supplied through an automatic ULTC transformer. When the voltage of the bus declines, an automatic tap change with the transformer has the effect of reducing the transformer reactance.
   - True   False

4. A ZIP load with a constant leading power factor of 0.9 is supported by a constant voltage source $E_R$ through two parallel lines. Its active load $P_R = P_0(a|V_R|^2 + b|V_R| + c)$ with $a$, $b$ and $c$ being all constants. By increasing $P_0$ from 0 until a voltage collapse at $|V_R| = 0.5|E_R|$, we may draw the PV curve at the load bus as shown in the figure, where the “nose” point has critical voltage $|V_R| = 0.6|E_R|$ and maximum power transfer $P_{RMAX}$
   1) There must be $a \neq 0$.
      - True   False
   2) Apply the modal analysis to the system condition at the “nose” point. The modal voltage and the modal reactive power variations are along the same direction.
      - True   False
   3) At the operating point with $|V_R| = 0.7|E_R|$, if a constant reactive power source is connected to the load bus, $|V_R|$ must be improved.
      - True   False
   4) At the operating point with $|V_R| = 0.7|E_R|$, if a shunt capacitor at the load bus is switched in, $|V_R|$ must be improved.
      - True   False
   5) If the power factor is changed to one, the new PV curve with the change of $P_0$ must have a higher critical voltage and a bigger $P_{RMAX}$
      - True   False
   6) If one of the two lines is opened, the new PV curve with the change of $P_0$ must have a lower critical voltage and a smaller $P_{RMAX}$.
      - True   False
5. Which of the following is (are) correct?

1) Since voltage stability is basically stability of loads, a system having all loads represented in static load models will never lose voltage stability.

2) When a quasi-dynamic analysis method is applied to assess voltage stability of a power system, reduced order differential equations are used to model the system for fast time-domain simulation.

3) Compared to a measurement-based method for voltage stability assessment, a simulation/model based method needs a steady-state powerflow solution as the base condition for its assessment.

4) Compared to a simulation/model-based method for voltage stability assessment, a measurement-based method is often called “model-free” since it does not adopt or assume any model on the power system. (Strictly speaking, it is not correct)