EEL 797 Power System Dynamics
Major Exam

Max Marks 50 **Time 2 hours**

1. Consider the three maehine, nine bus system. All loads are represented by constant impedances. Maehine 1 is modeled as classieal, machine 2 modeled as voltage behind subtransient reactance, and maehine 3 is modeled as a 2 axis model. Write the state veetor and the input veetor for the eombined system.

(2+2)

2. The purpose of axis transformation is to transform the machine quantities at local frame to network frame of reference. Consider a two-pole induction motor, rotating at 2800 rpm.
   a. What is the speed of rotation of the local d-q axis?
   b. What modification must be done to the axis transformation matrix, *T*?

(2+2)

3. A salient pole machine does not allow *d*-axis field winding unlike a round rotor machine, whose solid steel rotor structure allows all currents to flow. (True/False)

(1½)

4. Voltage behind subtransient reactance model for a round rotor machine must incorporate an extra winding on the rotor known as 'G' winding (True/False)

(1½)

5. Consider a single machine connected to an infinite bus through a double circuit. At 0.1 s, one of the parallel line trips, ***without any fault.*** The system remains transient stable. Ignoring mechanical damping,
   a. Draw the equal area criterion for the event
   b. Plot the kinetic energy and the potential energy of the system from 0s to an *appropriate* length of time. Connect this plot to the plot you obtained above.
   c. If the transient energy function (TEF) is composed of the kinetic energy and the potential energy, plot its evolution for the same time. Connect this to the plot obtained in (a).

(3+6+3)

6. What is the difference between the direct method and the traditional method of stability assessment?

(3)

7. Consider a dynamic system, whose Lyapunov function is $V_L=2x-x^2$. What can you conclude about the stability of the system?

(2)

8. Ideal location of PSSs in a power system, where generation is remotely located from the load centres, is

a. Close to the critical loads to stabilize during transient swings,
b. Strategic buses to provide voltage support during impending blackout conditions,
e. All load buses to improve dynamic performance of the loads,
d. Generators

(2)

9. Draw the phasor diagram for $\bar{E} = \bar{V} + r\bar{I}_a + j\left(x_q\left(I_a - I_d\right) + x_d I_d\right)$, considering leading power factor.

(5)

10. What is the effect of voltage regulation on the armature reaction of a synchronous machine?

(3)

11. What is the relation between the
    a. participation factor and the eigenvalue sensitivity?
    b. left and right eigenvector of the same mode,

(1½+1½)

12. In a multi-machine system, for the following contingencies
    a. lightly loaded line trips at 0.1s without any fault, plot potential energy
    b. fault at 0.1s, cleared at 0.2s by tripping a line, plot potential and kinetic energy

    The system remains stable for all the events. Ignore all damping and energy dissipation in the system.

(3+6)

Extra Credit

1. Write the swing equation for the two-axis model.

(3)