A DC motor is formed of the following circuit: a voltage source $V_s$, a resistance $R$, an inductance $L$, all in series with a gyrator of torque constant $K_i$, and electromotive constant $K_e$. It is desirable to operate the motor at a natural frequency greater than 7 rad/s and a damping ratio $Z$ greater than 0.5. The gyrator is connected via a rigid shaft to a body of moment of inertia $J$ rotating at angular speed $dT/dt$.

1 – Neglect the inductance in the circuit and derive the transfer function of the system. When is it safe to disregard the inductance term of the circuit?

2 – Draw a root locus for the system. Can gain controller achieve the desired properties of the poles? Explain.

3- Suppose that the gain controller is replaced by a PD controller. Draw the corresponding root locus. Can the new controller achieve the desired properties of the poles?

4 – If the controller used is now of the lead-lag type, where would the poles be located?