ECE 431 homework #8_ extra credit (Due – Wednesday, May 6, 2019)

A dc machine has the parameters:

Rated armature voltage	500 V
Rated armature current	350 A
Rated speed	1000 rpm
Maximum speed	3000 rpm
Armature Resistance	0.02 Ω
Armature Winding Inductance	0.2 mH
Moment of inertia (whole drivetrain)	5 kg-m^2
Field winding rated voltage	250 V
Field winding rated current	1.25 A
Field constant (k_f)	0.75 H
Field winding resistance	200 Ω
Field winding inductance	20 H

The machine has negligible remnant field.
The machine is separately excited with a fixed 250V field supply.

(a) Compute the armature voltage needed to attain a no load speed of 1000 rpm
(b) The motor is connected to a load with a torque characteristic given by $T_{load} = 0.03\ \omega^2$, and the field winding is connected to rated field voltage at t<0 (The initial condition of the field current is the rated value). At time t=0, the motor is connected to the above determined armature voltage. Compute and plot the speed variation that will be observed.
(c) Design a voltage controller of the form $V_a = V_{a0} + G\ (\omega_{ref} - \omega_m)$ to limit the speed variation to 2% while the load is increased from no load, 1000 rpm, to rated load. Redo the simulation in (b) incorporating this voltage control. Find and plot steady state speed and load torque as a function of G