Problem 1
In Fig. 1 is shown an RLC circuit with a DC voltage source.

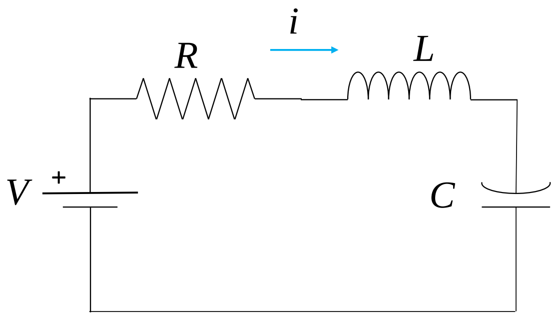
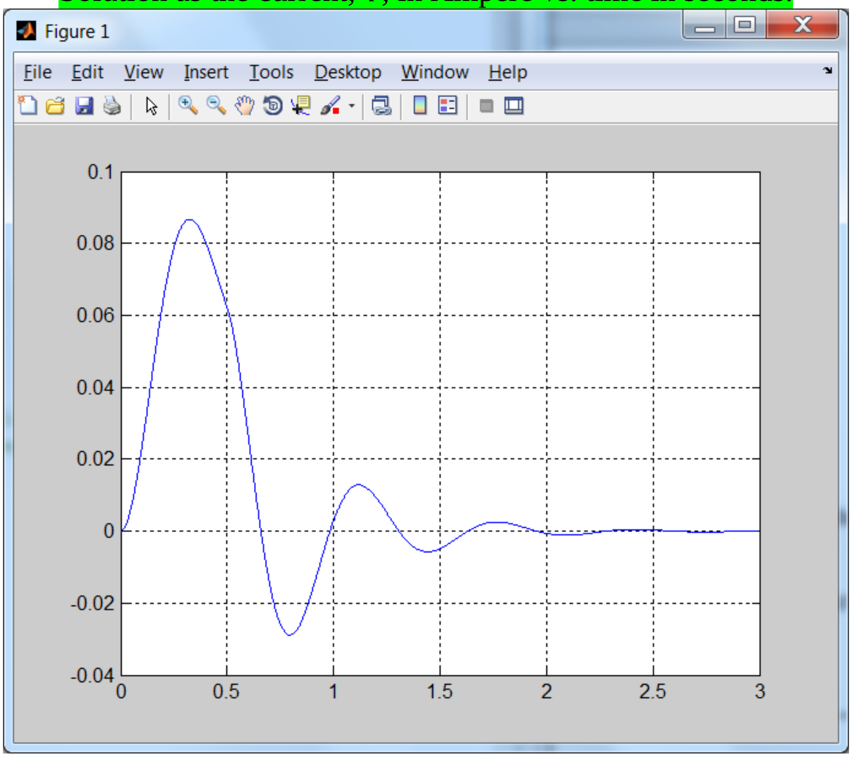


Figure 1 Electric circuit consisting of a DC voltage source, a resistor, an inductance and a capacitance.

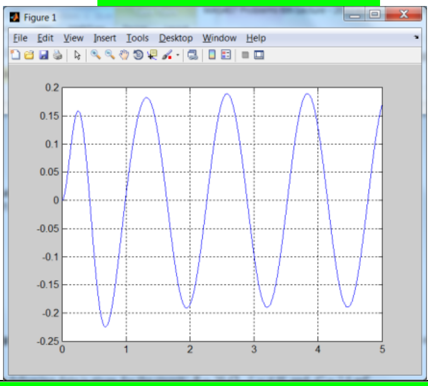
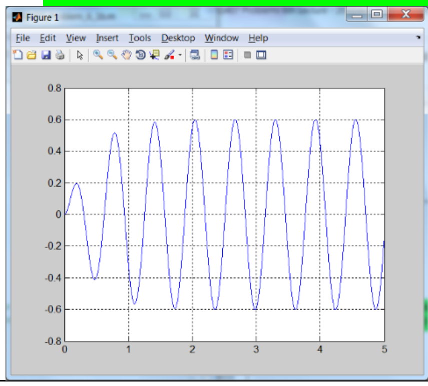
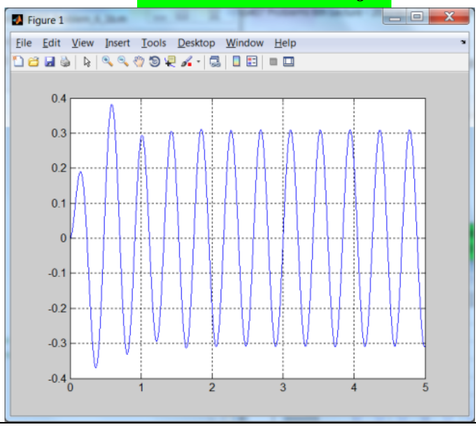
The following data is given for the circuit: $R = 20\ \Omega$, $L = 4\ H$ and $C = 2.5\ mF$.
The DC voltage source is ramped up from 0 V to 12 V in 0.5 seconds.
Initially there is no current in the inducance and no voltage drop across the capacitance.
Simulate the system for a period of 3 seconds.

Solution as the current, i, in Ampere vs. time in seconds.



The voltage source is replaced with an AC voltage source. The voltage amplitude of the AC voltage source is $\sqrt{2} \cdot V = 12V$ or RMS value of $V = 8.485V$ and the frequency may have three different values: $\omega = [5 \quad 10 \quad 15] \frac{rad}{s}$.
In the time domain this corresponds to a supply voltage of $V_s = \sqrt{2} \cdot V \cdot \sin(\omega \cdot t)$
Initially there is no current in the inducance and no voltage drop across the capacitance.

Simulate the system for a period of 5 seconds for all three different frequencies.

Solution as the current, i, in Ampere vs. time in seconds for $\omega = 5 \frac{rad}{s}$. 	Solution as the current, i, in Ampere vs. time in seconds for $\omega = 10 \frac{rad}{s}$. 
Solution as the current, i, in Ampere vs. time in seconds $\omega = 15 \frac{rad}{s}$. 	

Problem 2
An electric circuit is shown in Fig. 2 and consists of a voltage supply, two resistors, and a capacitor. The two resistances have the same resistance $R_1 = R_2 = 200\ \Omega$. The capacitance of the capacitor is $\mathrm{C} = 60\ \mu\mathrm{F}$. The supply voltage is ramped up to a constant value of $\mathrm{U_S} = 12\ \mathrm{V}$, according to Fig. 3.

At time t = 0 s the voltage drop across the capacitor is $\mathrm{U_C} = 24\ \mathrm{V}$.

Make a simulation model of the electric circuit in Matlab and plot the two currents i_1 and i_2 from t = 0s to t = 0.5s. Also, plot the voltage drop across the capacitor.

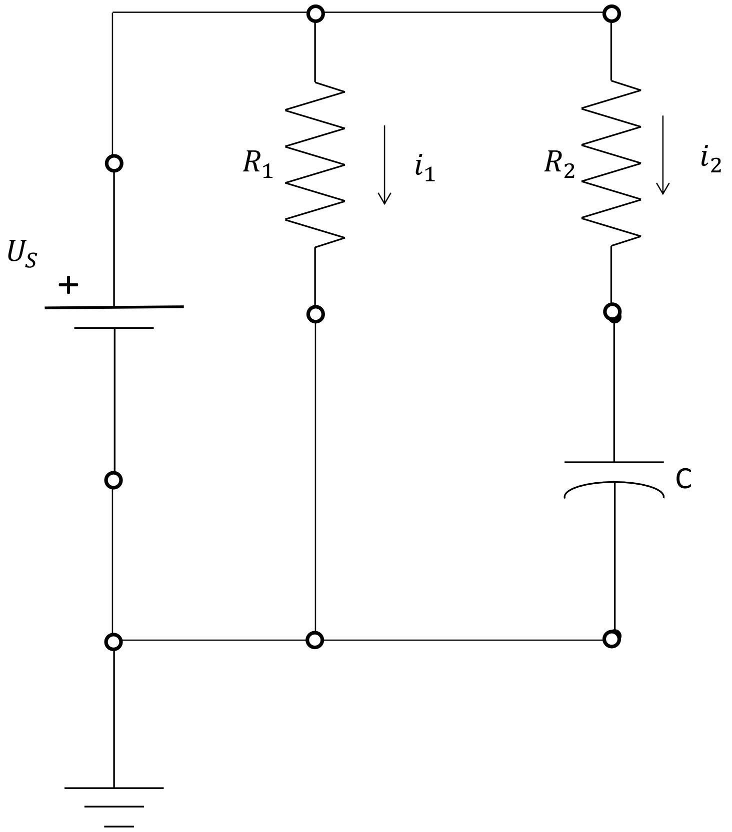


Figure 2 Electric cicuit.

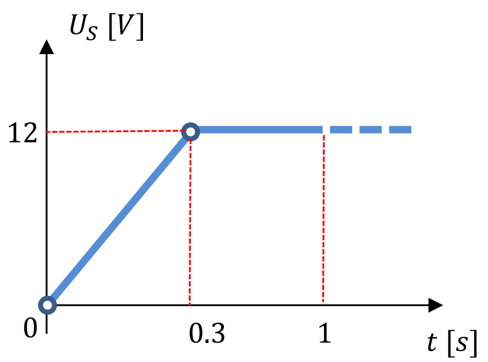
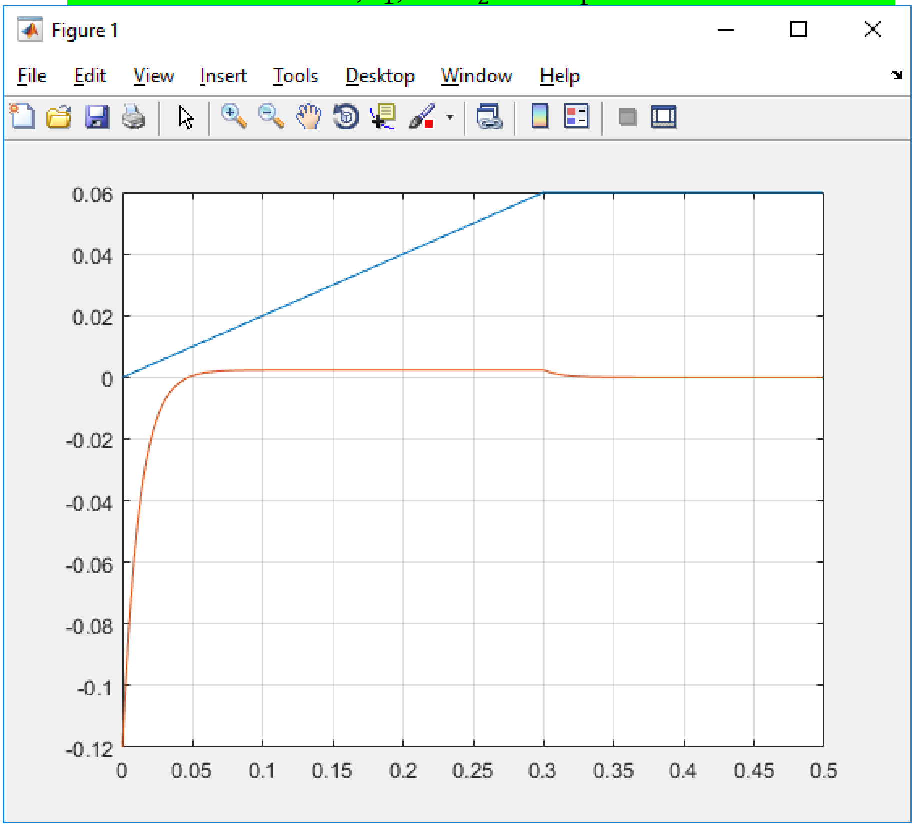
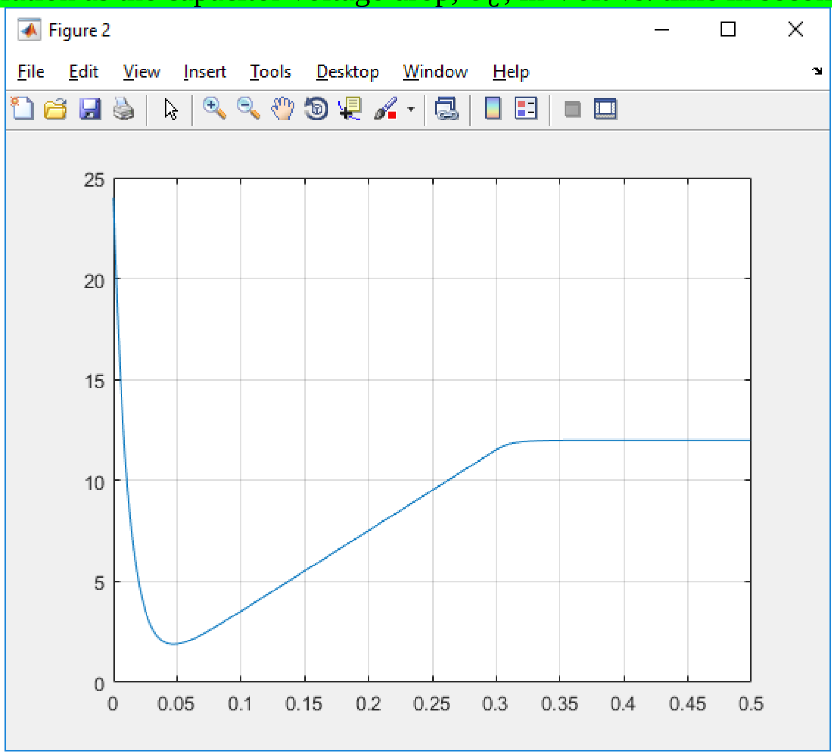


Figure 3 Variation of voltage supply vs. time.

Solution as the current, i_1, and i_2 in Ampere vs. time in seconds.



Solution as the capacitor voltage drop, U_C, in Volt vs. time in seconds.

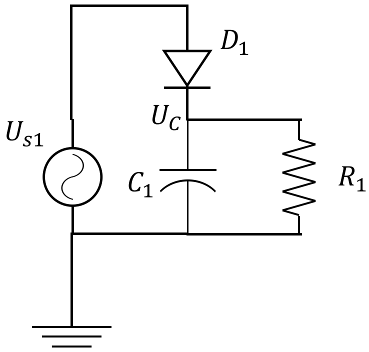


Problem 3
An electric circuit is shown in Fig. 3 and consists of an AC voltage source, a diode, a resistor, and a capacitor.
The resistance is $R_1 = 1500\ \Omega$. The capacitance is $C_1 = 60\ \mu F$. The RMS value of the voltage source is $V_1 = 120$ V and the frequency is $f_1 = 50\ Hz$.

The diode minimum resistance can be set to $R_{D1} = 1\ \Omega$

At time t = 0 s the voltage drop across the capacitor is $U_C = 0$ V .

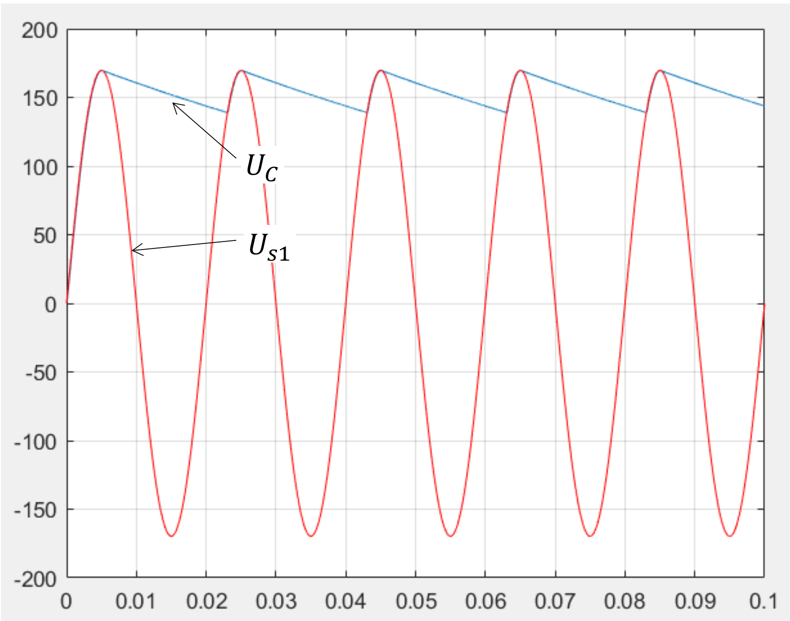
Make a simulation model of the electric circuit in Matlab and plot the capacitor voltage, U_C, and the supply voltage, U_{s1}, from t = 0s to t = 0.1s.



$$U_{s1} = \sqrt{2} \cdot V_1 \cdot \sin(2 \cdot \pi \cdot f_1 \cdot t)$$

Figure 4: Electric circuit

Solution as the capacitor voltage drop, U_C, and the supply voltage, U_{s1} in Volt vs. time in seconds.



Problem 4

An electrical system is shown in Figure 5. It consists of two voltage supplies U_{S1} and U_{S2}, five resistances $R_{1..5}$, two capacitors $C_{1..2}$, and a single inductance L_1.

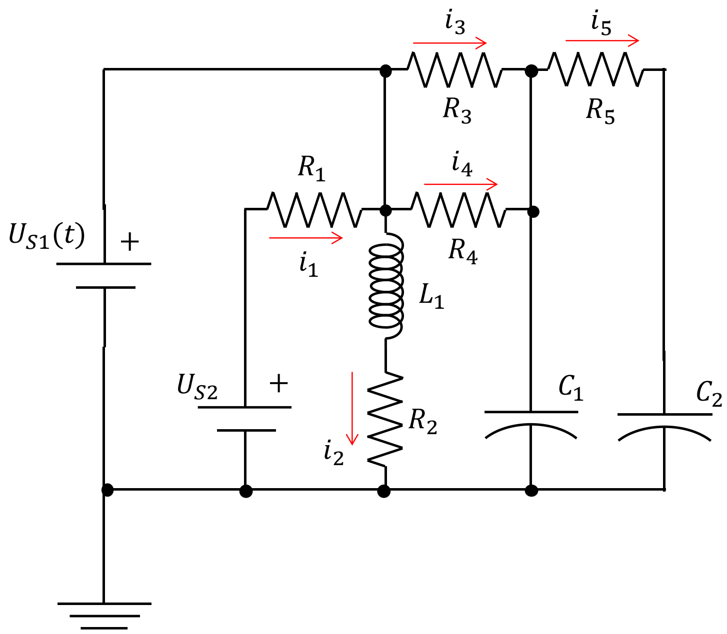


Figure 5 Electrical system.

The following data is given: $R_1 = 5000\ \Omega$, $R_2 = 2000\ \Omega$, $R_3 = R_5 = 1200\ \Omega$, $R_4 = 8000\ \Omega$, $C_1 = C_2 = 380\ \mu F$, and $L_1 = 50\ H$.

The first voltage supply is a function of time as shown in Figure 6:

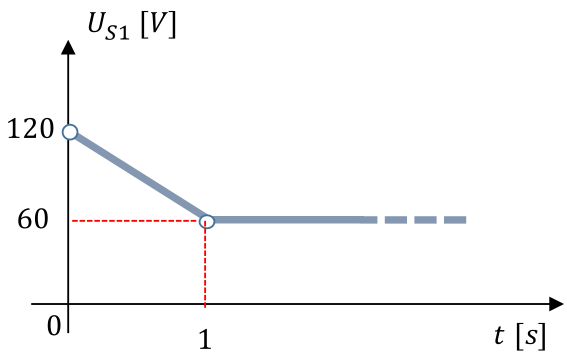


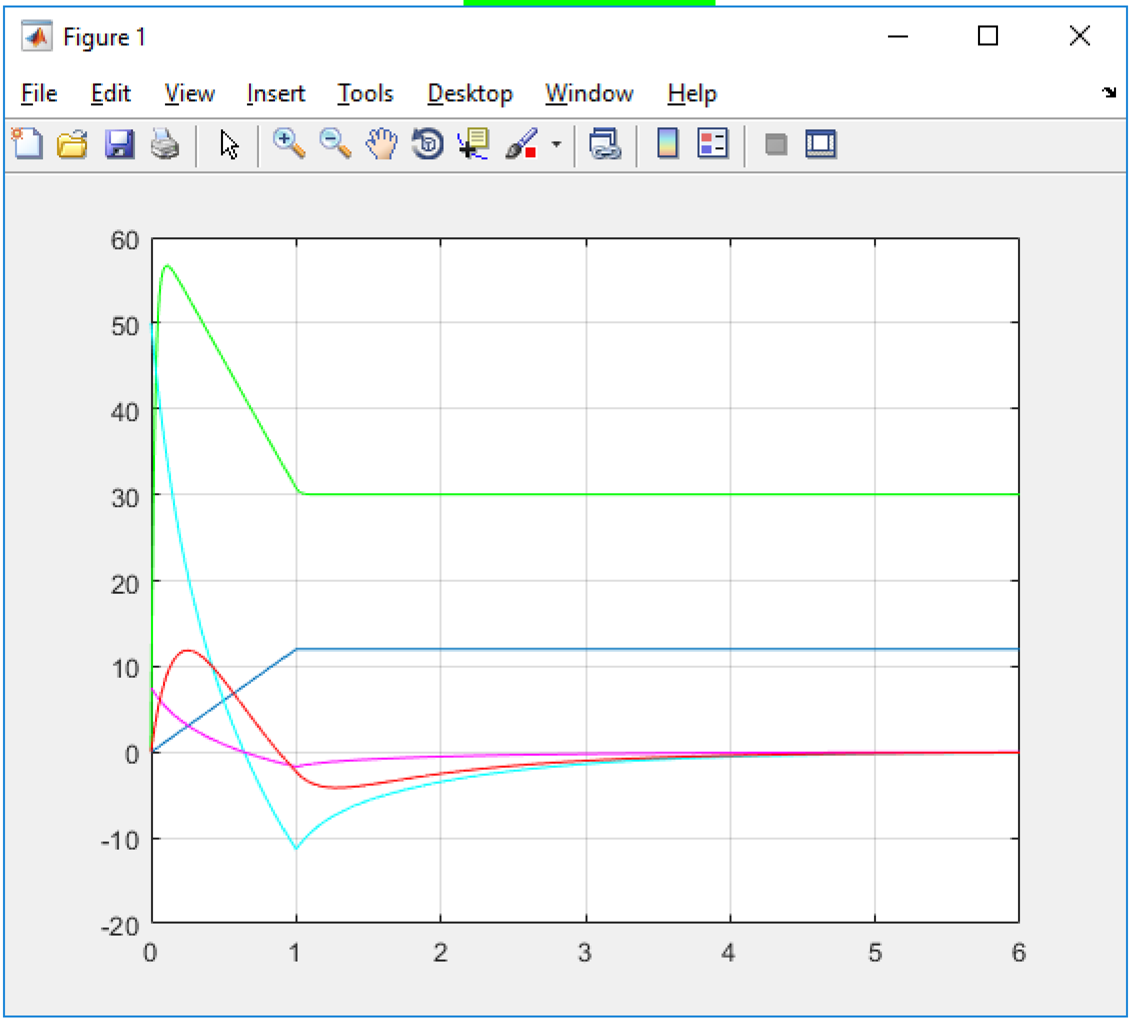
Figure 6 The voltage supply, U_{S1}, as a function of time.

The second voltage supply is constant at $U_{S2} = 120\ V$.

At time $t = 0\ s$ the voltage drops across the capacitances are $U_{C1} = U_{C2} = 60\ V$ and the current through the inductance is $i_2 = 0\ A$.

Make a simulation model of the electrical system and simulate from $t = 0\ s$ to $t = 6\ s$.
Plot the currents $i_{1..5}$ as a function of time.

Solution as the current, i_1 (blue), i_2 (green), i_3 (cyan), i_4 (magenta), and , i_5 (red) in mA vs. time in seconds.



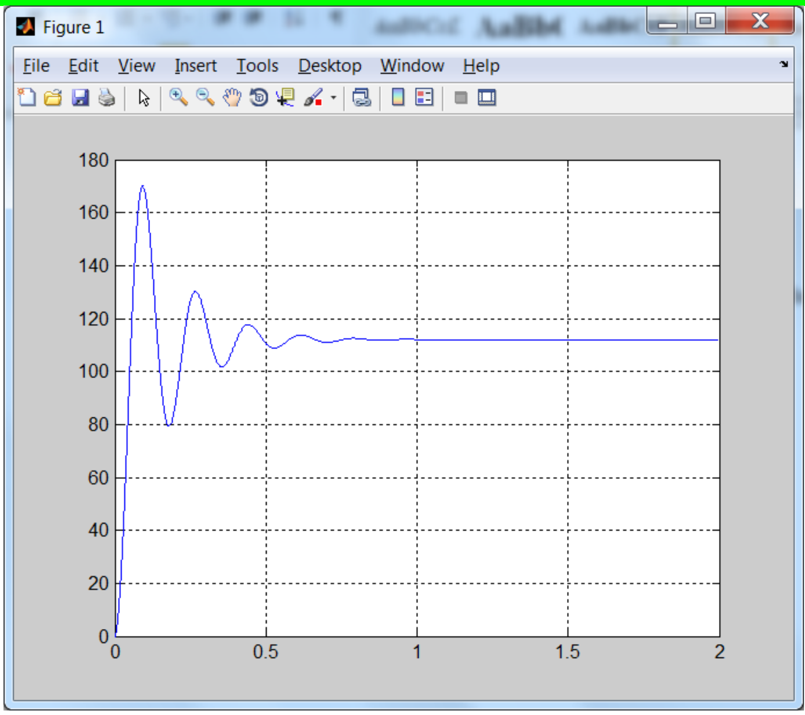
Problem 5

A DC motor is described by the following data: $J_m = J_{eff} = 2.5 \cdot 10^{-4}\ kg \cdot m^2$, $V_a = 12\,V$,
$R_a = 0.4\ \Omega$, $L_a = 0.03\ H$, and $K_m = 0.1\ \frac{N \cdot m}{A}$.

The load on the rotor is a friction torque given as: $M_L = M_{fr} \cdot \tanh\left(\frac{\omega_m}{\omega_{fr}}\right)$, where $M_{fr} = 0.2\ N \cdot m$ and $\omega_{fr} = 20\ \frac{rad}{s}$.

Initially the rotor has no rotation and is at rest. Also, initially, there is no current in the armature inductance.
Simulate the system for a period of 2 seconds.

Solution as the motor speed, ω_m, in radians pr. second vs. time in seconds.



Problem 6

A three-phase short circuited induction AC motor is described by the following data:

$J_m = J_{eff} = 0.005\ kg \cdot m^2$, $V_p = 220\ V$, $p = 2$, $f_s = 50\ Hz$, $R_s = 2\ \Omega$, $R_r = 2.5\ \Omega$, $L_s = 0.025\ H$, and $L_r = 0.015\ H$.

The load on the rotor is a friction torque given as: $M_L = M_{fr} \cdot tanh\left(\frac{\omega_m}{\omega_{fr}}\right)$, where $M_{fr} = 3\ N \cdot m$ and $\omega_{fr} = 20\ \frac{rad}{s}$.

Initially the rotor has no rotation and is at rest. Simulate the system for a period of 1 seconds.

Solution as the motor torque, M_m, in Newton-meter vs. time in seconds.