Week 1

Problem 1: (50 points) A dynamic vibration absorber is shown in Figure 1. This system is representative of many situations involving the vibration of machines containing unbalanced components. The parameters M2 and k12 maybe chosen so that the main mass M1 does not vibrate in the steady state when F(t) = 2 * sin (10 * t)

Obtain the differential equations describing this system.

Simulate this system for 10 seconds. M1 = 100. K1 = 50. b = 50.

Find the optimal value for M2 and k12 so that M1 does not vibrate.

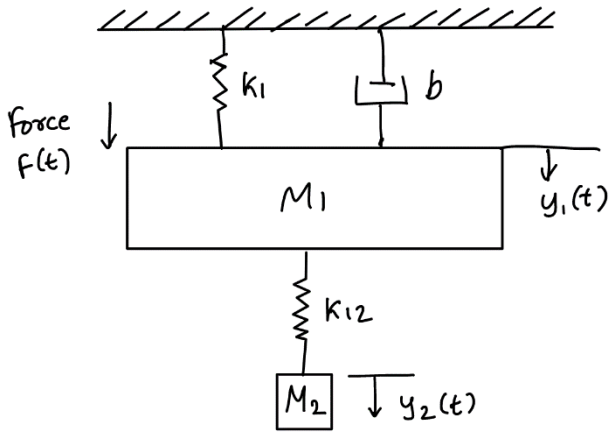


Figure 1

Problem 2: (50 points) The suspension system for one wheel of an old-fashioned pickup truck is illustrated in figure 2. The mass of the vehicle is m1 and the mass of the wheel is m2. The suspension spring has a spring constant k1 and the tire had the spring constant k2. The damping constant of the shock absorber is b. Obtain the mathematical model which represent the vehicle response to bump in the road and simulate it for 100 sec. Create a dummy input signal to represent the bumpy road using MATLAB program.

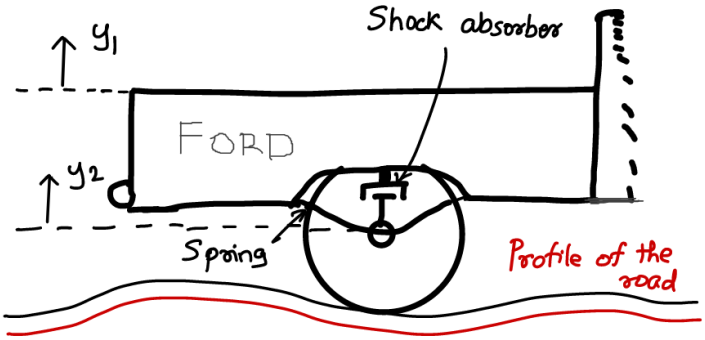


Figure 2

Problem 3: (50 points) Using the bilinear transformation, design a highpass filter, monotonic in passband with cutoff frequency of 1000 Hz and down 10 dB at 350 Hz. The sampling frequency is 5000 Hz. Implement using basic building blocks. Show the derivation for this filter. Demonstrate the filter's output for 5 different frequencies ranging from 100 Hz to 10000 Hz. Choose these frequencies smartly to demonstrate the filter working.

Problem 4: (20 points) Realize the filter described by difference equation

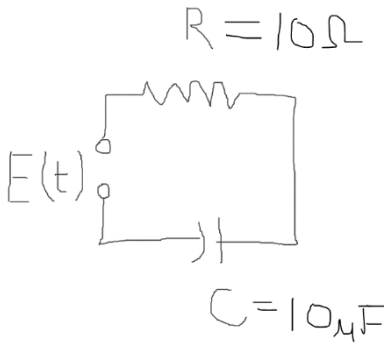
$$\mathbf{y(n)} = \mathbf{0.5} * \mathbf{y(n-1)} - \mathbf{0.25} * \mathbf{y(n-2)} + \mathbf{x(n)} + \mathbf{0.4} * \mathbf{x(n-1)}$$

Problem 5: (30 points) For the circuit shown in Figure 3, the equation is

$$R\frac{dQ}{dt} + \frac{1}{C}Q = E(t)$$

Simulate this equation for 10 seconds for 5 different initial conditions and inputs E(t)

Figure 3



Problem 6: (30 points) For the FIR filter with function below determine the direct form realization.

$$\mathbf{H(z)} = \mathbf{1} + \mathbf{2z^{-1}} - \mathbf{3z^{-2}} - \mathbf{4z^{-3}} + \mathbf{5z^{-4}}$$

Build this filter using basic building blocks in Simulink. Make this a reference model.

Problem 7: (30 points) Obtain the cascade realization of system function

$$\mathbf{H(z)} = (\mathbf{1} + \mathbf{2z^{-1}} - \mathbf{z^{-2}})(\mathbf{1} + \mathbf{z^{-1}} - \mathbf{z^{-2}})$$

Build this filter using basic building blocks in Simulink. Make this a reference model.

Problem 8: (100 points) Design a lift for a 5-floor building using Stateflow. Use your creativity.

Demonstrate following skills

1. Flowchart
2. State Machines
3. Hierarchy
4. Parallel logic
5. Events
6. Stateflow Function

Problem 9: (100 points) Design a BLDC motor using basic Simulink blocks. Use equations from any reference book or from the internet. Cite the source for the equation. Demonstrate a speed control system with this motor.

Problem 10: (40 points) Build a diode model using Lookup table.

Simulate it with an appropriate input signal.