Earthquake engineering homework4

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In this nonlinear dynamic SDOF system problem, we know that：

mass = 1 (kip*s^2/inch)

zeta = 0.05

stiffness 1 (k1) = 631.65 (kip/inch)

stiffness 2 (k2) = 126.33 (kip/inch)

yielding displacement (x_y) = 1 (inch)

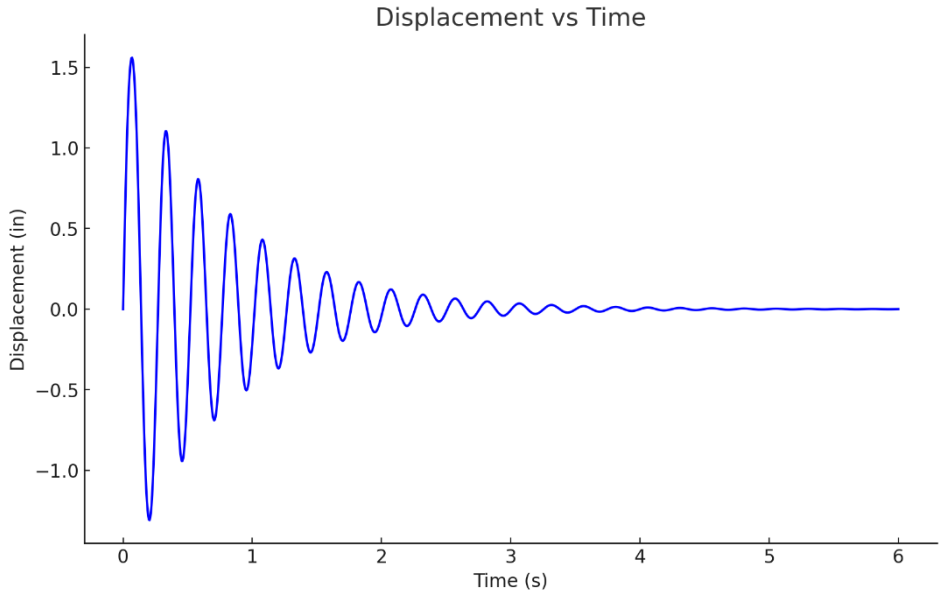
initial displacement x_0 = 0 (inch)

initial velocity $\dot{x}_0$ = 40 (inch/s)

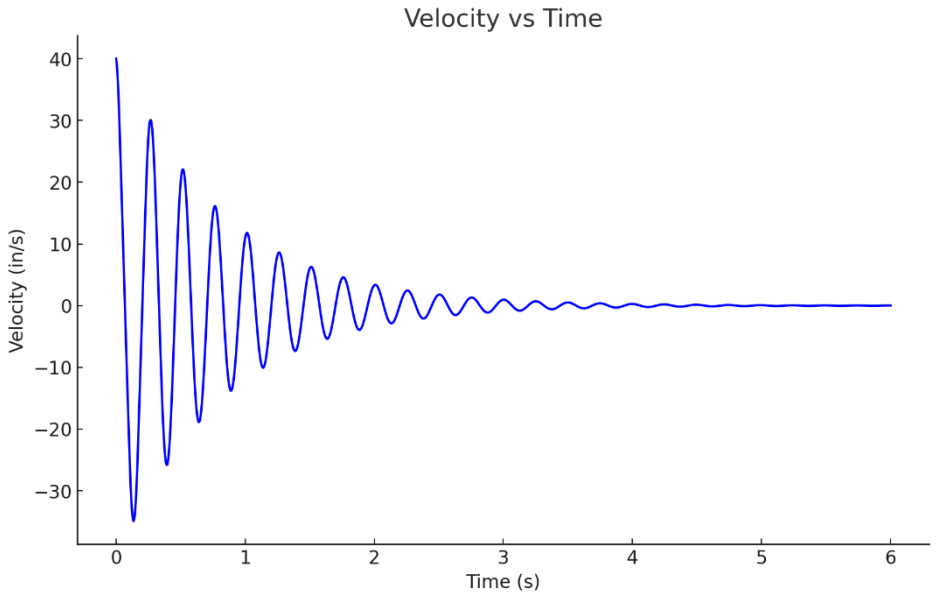
the unit time interval of analyzing the problem Δt = 0.005 (s)

use Average Acceleration Method to calculate the response of the system.

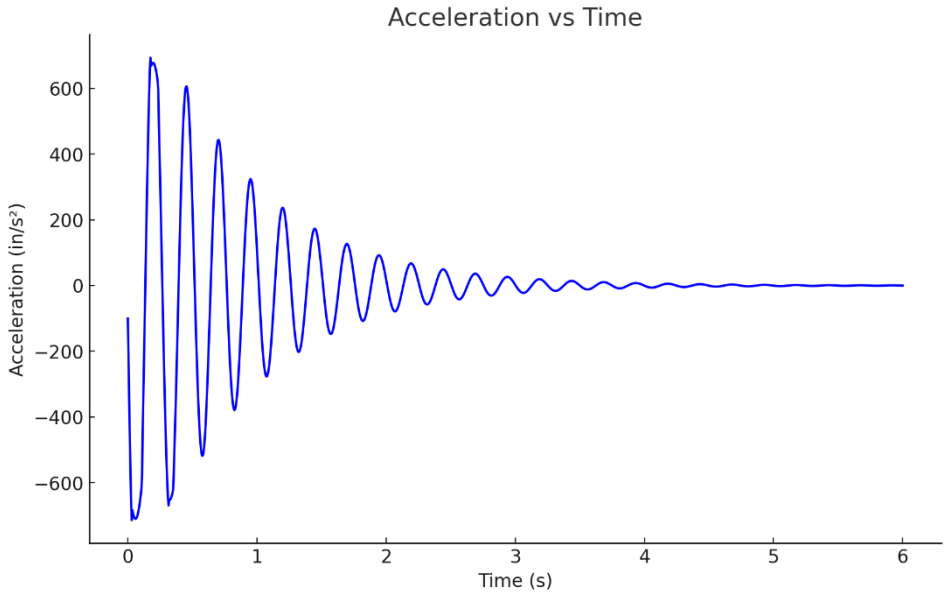
1. x(t)



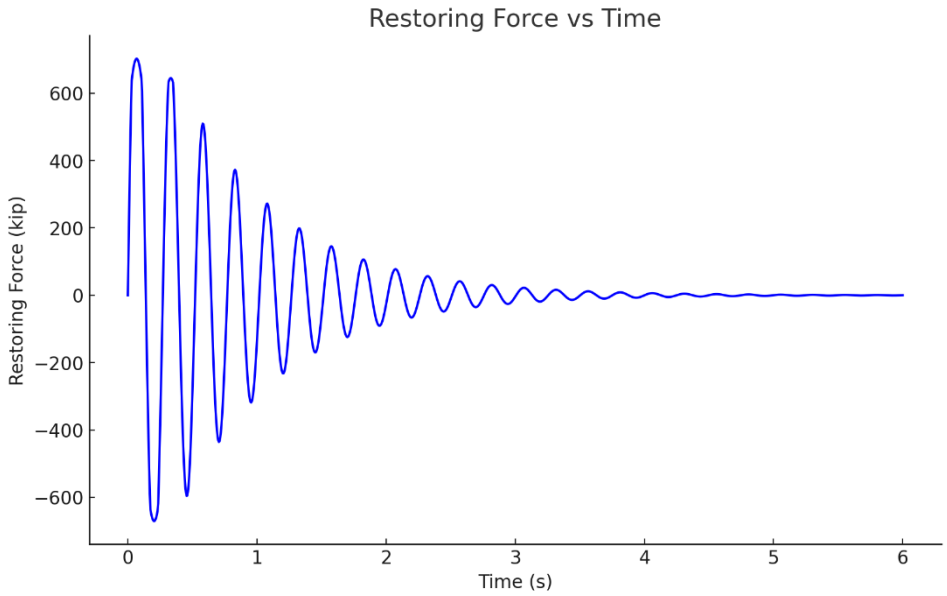
2. $\dot{x}$(t)



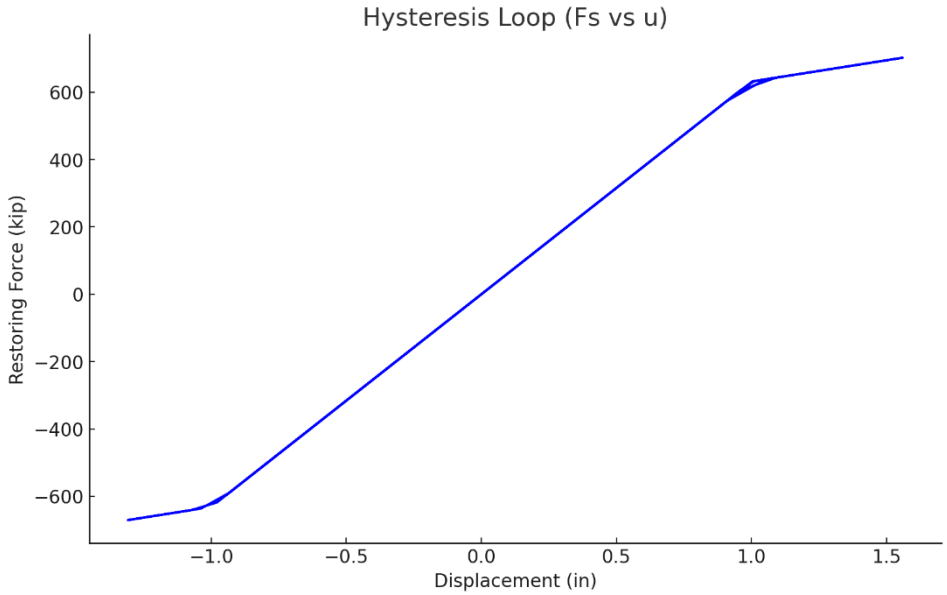
3. $\ddot{x}$(t)



4. Fs(t)


Restoring Force vs Time
Restoring Force (kip)
600
400
200
0
−200
−400
−600
0
1
2
3
4
5
6
Time (s)

5. Fs(x)


Hysteresis Loop (Fs vs u)
Restoring Force (kip)
600
400
200
0
−200
−400
−600
−1.0
−0.5
0.0
0.5
1.0
1.5
Displacement (in)

6. List the first six steps of problem analyzing process:

time	u	v	a	Fs
0	0	40	-100	0
0.005	0.197981	39.34622	-223.025	125.0548
0.01	0.391184	38.08298	-341.515	247.0913
0.015	0.576629	36.23523	-453.655	364.2277
0.02	0.751484	33.83684	-557.747	474.6748
0.025	0.913106	30.93	-652.233	576.7632
0.03	1.059081	27.56448	-735.718	639.1137

7. List the specific point where the nonlinear property needs to be corrected.

Point	time	u(t)	v(t)	a(t)	Fs
a	0.025	0.912948	30.917828	-652.6337	639.0855
	0.03	1.058858	27.550362	-736.0721	
b	0.065	1.59996	3.121052	-710.8935	708.2943
	0.07	1.6067	-0.429497	-707.7585	
c	0.17	-0.33723	-15.102896	553.5855	-562.7746
	0.175	-0.4056	-12.289964	589.5885	
d	0.195	-0.53548	-0.682877	579.9451	-578.7008
	0.2	-0.53167	2.212186	576.2149	
e	0.295	0.965788	15.240678	-402.4071	449.9758
	0.3	1.036715	13.179272	-441.9029	
f	0.34	1.965924	31.688055	440.2102	580.4541
	0.345	2.129723	33.860229	417.1085	