RBT 2 HW 1 Aly Khater

1)

a) second order
b) first order
c) nonlinear
d) linear
e) parameters are not time dependant
f) Easier to compute.
g) sine wave, w/ A amplitude and $\frac{1}{w}$ frequency
h) The response results for the addition of each input.
i) Apply appropriate laws. Combine expressions to solve and describe system
j) $F = m\frac{d}{dt}V$
k) current and voltage KCL, KVL
l) $f = -kx$, $f = -bv$
m) $V = IR$, $Q = CV$
n) exponential
o) $1 - e^{-1}$
p) less responsive
q) $V = IR$
r) underdamped, overdamped, critically damped
s) yes
t) False
u) $kg\frac{m^2}{s^2}$
v) gravity. Gravity creates a torque, so it will constantly tilt further
v) The top now has an angular velocity.

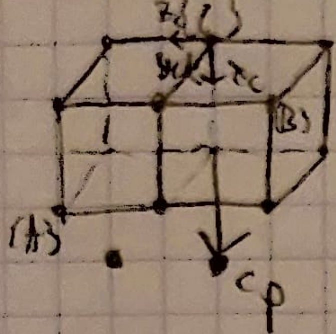
2

a) The parameter
b) The parameter
c) no output feedback to controller
d) cheap, simple
e) Output feedback to controller to adjust
f) reduce errors, increase performance
g) Stability, steady state, transient
h) Yes
i) Yes
j) Proportional, Intergral, Derivative
k) Integral
l) Derivative
m) linear
n) Gravity. Cannot eliminate disturbance

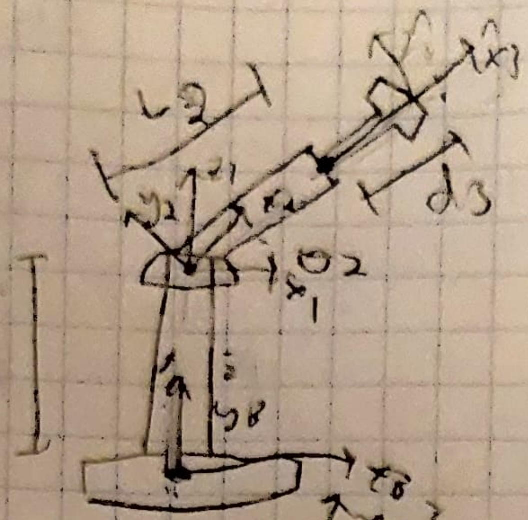
3 a) $${}^{A}_{B}T = \begin{pmatrix} 0 & -1 & 0 & 2 \\ 0 & 0 & 1 & 0 \\ -1 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

b) $${}^{C}_{B}T = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & -1 & 1 \\ 0 & 1 & 0 & -1 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

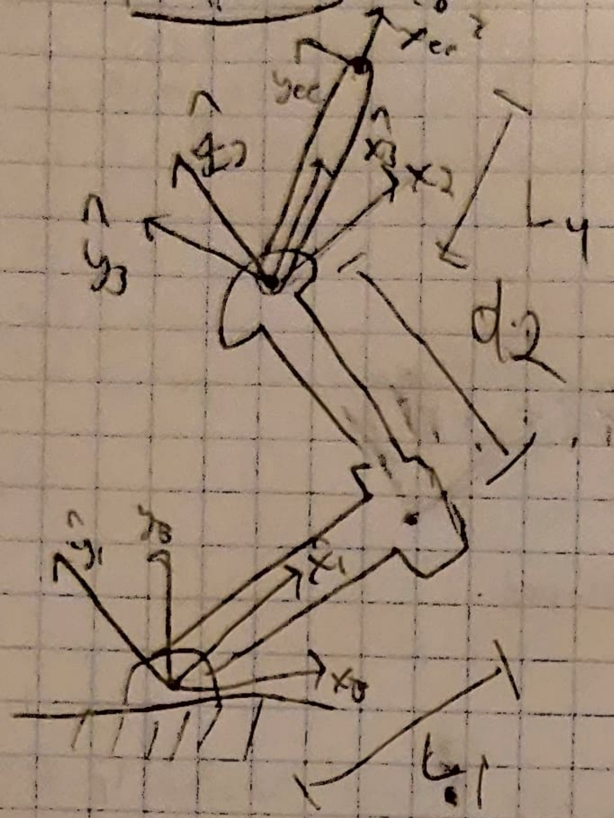
c)



4



i	α_{i-1}	a_{i-1}	θ_i	d_i
1	-90	0	0	d_1
2	90	0	θ_2	0
3	-90	0	-90	$L_2 + d_3$



i	α_{i-1}	a_{i-1}	θ_i	d_i
1	0	0	θ_1	0
2	-90	L_1	0	d_2
3	90	0	θ_3	0
ee	0	L_4	0	0

(5) $m\ddot{x}+b\dot{x}+kx=0 \quad m=2,\ b=6,\ k=4$

$2\ddot{x}+6\dot{x}+4x=0 \qquad x(0)=1$

$2s^2+6s+4=0 \qquad \dot{x}(0)=0$

$s^2+3s+2=0$

$(s+2)(s+1)=0$

$s=-2,-1$

$x(t)=C_1e^{-t}+C_2e^{-2t}$

$\dot{x}(t)=-C_1e^{-t}-2C_2e^{-2t}$

$x(0)=C_1e^0+C_2e^0=1$

$C_1+C_2=1$

$\dot{x}(0)=-C_1e^0-2C_2e^0=0$

$C_1+2C_2=0$

$C_1=-2C_2 \qquad -2C_2+C_2=1$

$-1C_2=1$

$\underline{C_1=2} \qquad \underline{C_2=-1}$

$x(t)=2e^{-t}-e^{-2t}$

SEE MATLAB

6

$m=1; b=4, k=5$ $\quad w_{res}=6$ rads/s.

Find k_v, k_p that will critically damp the system

Critical Damping $\quad b'=2\sqrt{mk}$ $\quad w_n=\sqrt{\frac{k_p}{m}}$

$$m\ddot{x}+(b+k_v)\dot{x}+(k+k_p)x=0$$

$$m\ddot{x}+b'\dot{x}+k'x=0 \qquad b+k_v=2\sqrt{m(k+k_p)}$$

$$w_n=\tfrac{1}{2}w_{res}=3$$

$$\ddot{x}+(4+k_v)\dot{x}+(5+k_p)x=0$$

$$s^2+(4+k_v)s+(5+k_p)=0$$

$$s^2+2\zeta w_n s+w_n^2=0$$

$$w_n^2=5+k_p$$

$$9=5+k_p$$

$$k_p=4$$

$\zeta=1$, critically damped

$$2\zeta w_n=4+k_v$$

$$2(3)=4+k_v$$

$$k_v=2$$

Problem 5

```
clc;
clear;
close all;
```

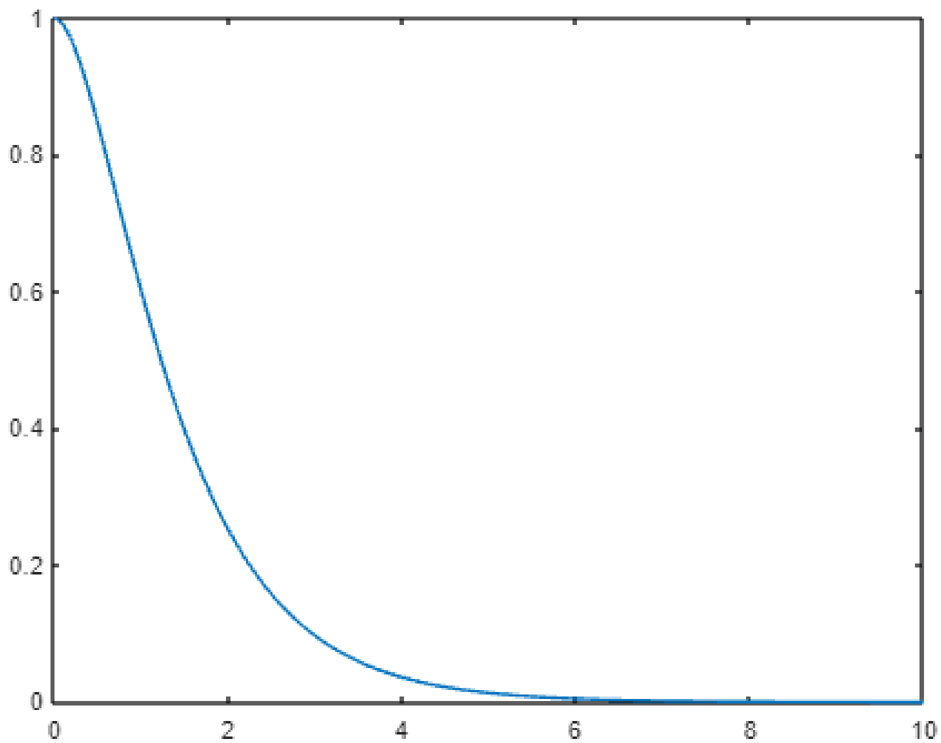
```
%Matlab Plot for x(t)
t = linspace(0,10,100)
```

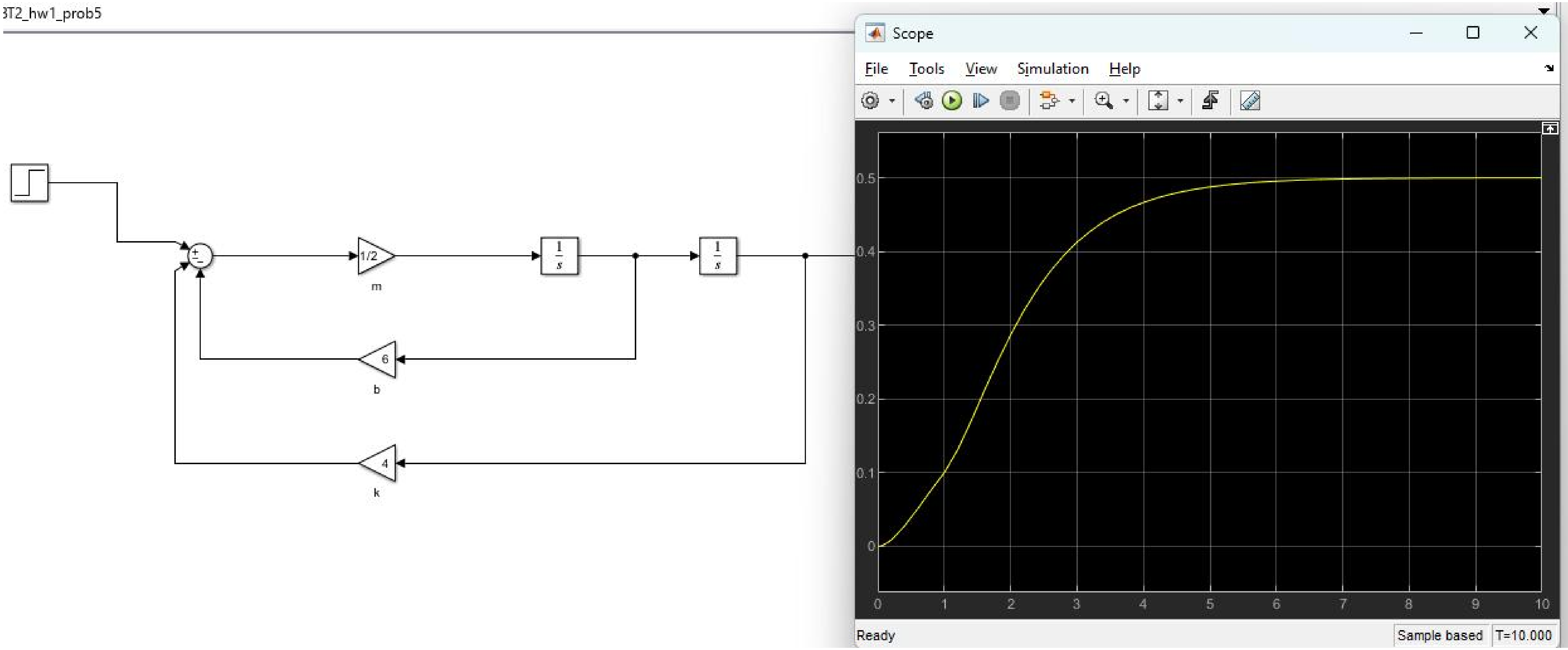
```
t = 1×100
         0    0.1010    0.2020    0.3030    0.4040    0.5051    0.6061    0.7071 ···
```

```
x = 2*exp(-t)-exp(-2*t)
```

```
x = 1×100
    1.0000    0.9908    0.9665    0.9317    0.8895    0.8428    0.7934    0.7430 ···
```

```
figure()
plot(t,x)
```




3T2_hw1_prob5
1/2
m
1/s
1/s
6
b
4
k
Scope
File Tools View Simulation Help
0.5
0.4
0.3
0.2
0.1
0
0 1 2 3 4 5 6 7 8 9 10
Ready
Sample based
T=10.000