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Question 1 - System Response

```
function yt = sys_response(sys, ut)
   % define the variables for laplace
   syms s t

   % take the laplace transform of the input function
   U_s = laplace(ut, t, s);

   % multiply the line above by the transfer function
   Y_s = sys * U_s;

   % taking the inverse laplace transform to find the output in time domain
   yt = ilaplace(Y_s, s, t);
end
```

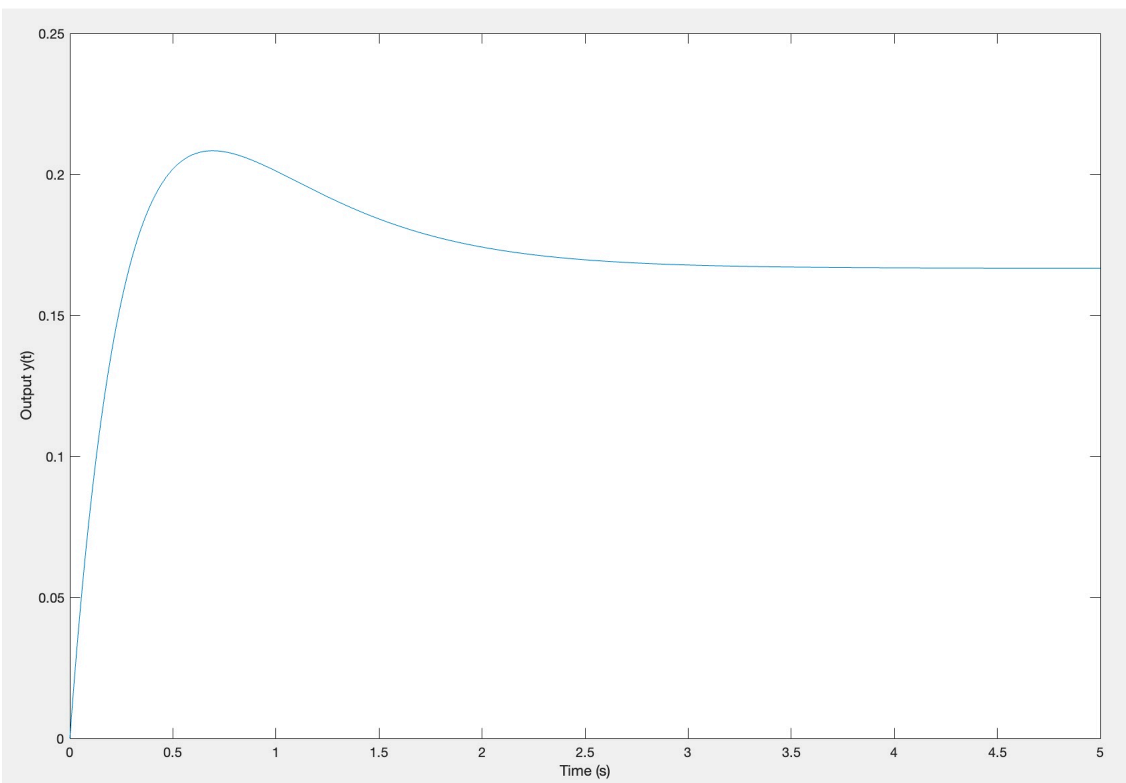
Question 2

Code:

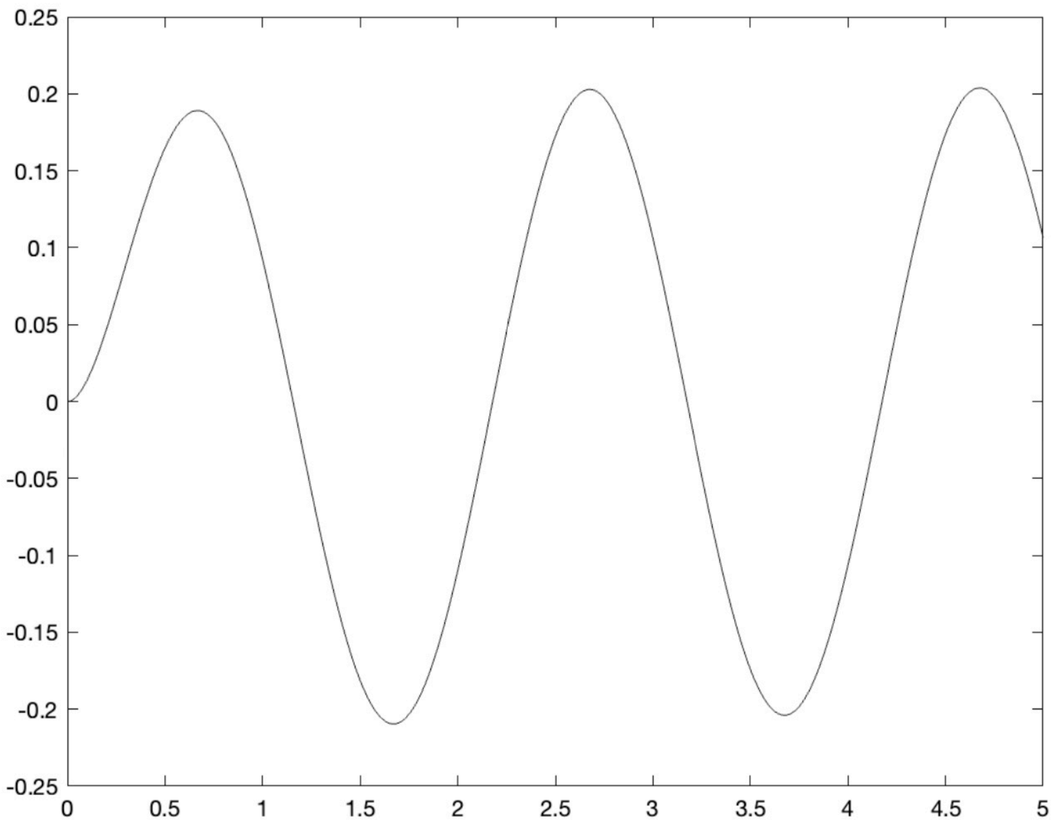
```
% define symbolic variables s and t
syms s t
sys = (s + 1) / (s^2 + 5*s + 6); % system transfer
ut = heaviside(t); % input is a step
% Calculate the system's output using the sys_response function
yt = sys_response(sys, ut); % input is a step
% compute numerical values of the output when time is from 0 to 5 sec, with
0.01 sec time intervals
time = 0:0.01:5;
y = double(subs(yt, t, time));
% plot output y(t)
figure;
plot(time, y);
xlabel('Time (s)');
ylabel('Output y(t)');
```

Plot:

For unit step input



For sin(pi*t) input



Problem 3

```
syms t
A = [0, 1; -3, -4];
% declare variable
I = eye(size(A));
% calculate (sI - A)^-1
inverse = inv(s*I - A);
% for loops for inverse laplace element-wise
for i = 1:size(A, 1)
   for j = 1:size(A, 2)
       ilaplaceMatrix(i, j) = ilaplace(inverse(i, j), t);
   end
end
% show answer
disp('L^-1(sI - A)^-1 is:');
disp(ilaplaceMatrix);
```

```
>> inverselaplace
L^-1(sI - A)^-1 is:
[    (3*exp(-t))/2 - exp(-3*t)/2,     exp(-t)/2 - exp(-3*t)/2]
[(3*exp(-3*t))/2 - (3*exp(-t))/2, (3*exp(-3*t))/2 - exp(-t)/2]
```

```
This matches exactly with my answers for part (a) and (b) from homework 2
question 2.
```

Problem 4

```
function F = fb_design(poles)
   A = [-1, 0; 0, -3];  % system dynamics matrix
   B = [1/2; -1/2];           % input matrix

   % using the place function to compute the feedback matrix F
   F = place(A, B, poles);

end
```

(a)

```
poles_a = [-4, -5];
F_a = fb_design(poles_a);
disp('feedback matrix F for poles [-4, -5]:');
disp(F_a);
```

When plugging in poles [-4, -5] the command line outputs the answer 12.000 and 2.000 which I then plugged into u = -Fx. This means the final answer is u = -[12 2]x which matches exactly with the homework problem.

(b)

```
poles_b = [-1 + i, -1 - i];
F_b = fb_design(poles_b);
disp('feedback matrix F for poles [-1 + i, -1 - i]:');
disp(F_b);
```

Feedback matrix F for poles [-1 + i, -1 - i]:

1.0000   5.0000