Assignment 3:

EEE3088F – Engineering design principles

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1.Write out an objective function for this problem. Make sure to include a "weighting parameter" you can modify to re-optimize if needed. Reading the next question will help...

F = (A*tR) + ((1-A)*mse)

Where:
A = weighing factor
tR = Rise time
mse = Mean square error

2.Using Matlab's fminsearchfunction, optimize the function above by simulating the Simulink model provided. Optimize it using three cases:

2.1. Only weight the sensor accuracy during steady-state. You can use the Mean-Square Error(MSE)for this metric.

To optimize for MSE:

A = 0,
tR = 19.5886 s
mse = 0 rad
omega, ω = 0.05 rad/s

F = (0*tR) + ((1-0)*mse)
➔F = 1*mse

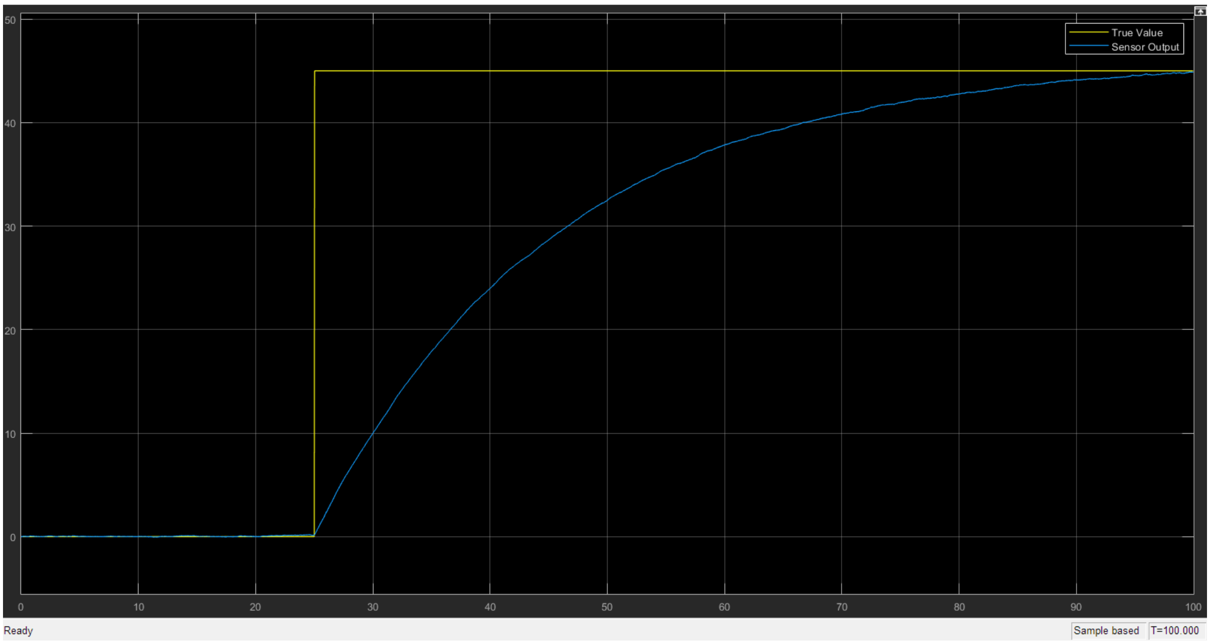


Figure 1: Sensor optimized for MSE

2.2. Only weight the speed of response of sensor. You can use the time it takes to get to 63% of the final value as your metric. This is often referred to as "rise time" in textbooks.

To optimize for rise time:

A = 1,
tR = 0.0267 s
mse = 21.5811 rad
omega, ω = 33.055 rad/s

F = (1*tR) + ((1-1)*mse)
➔F = 1*tR

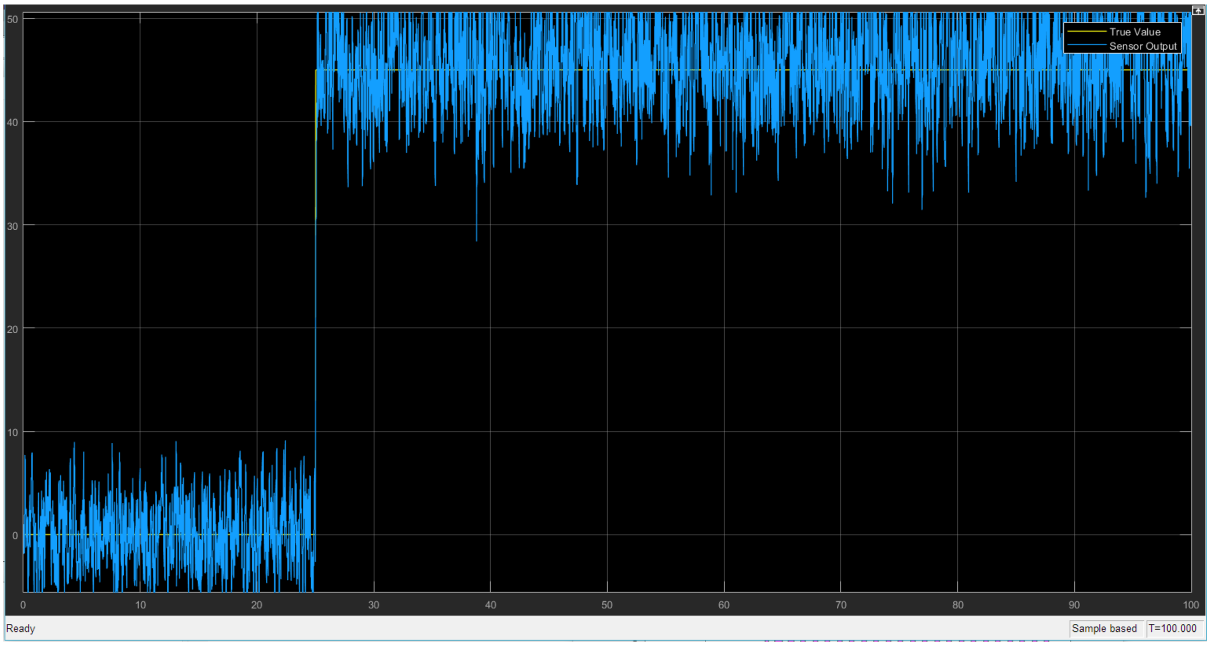


Figure 2: Sensor optimized for rise time

2.3. Draw a plot of MSE and Rise Time, varying your weighting parameter from only favouring MSE to only favouring Rise Time. What value of omega best satisfies both parameters? Assume equal unit weighting between MSE and rise time parameters

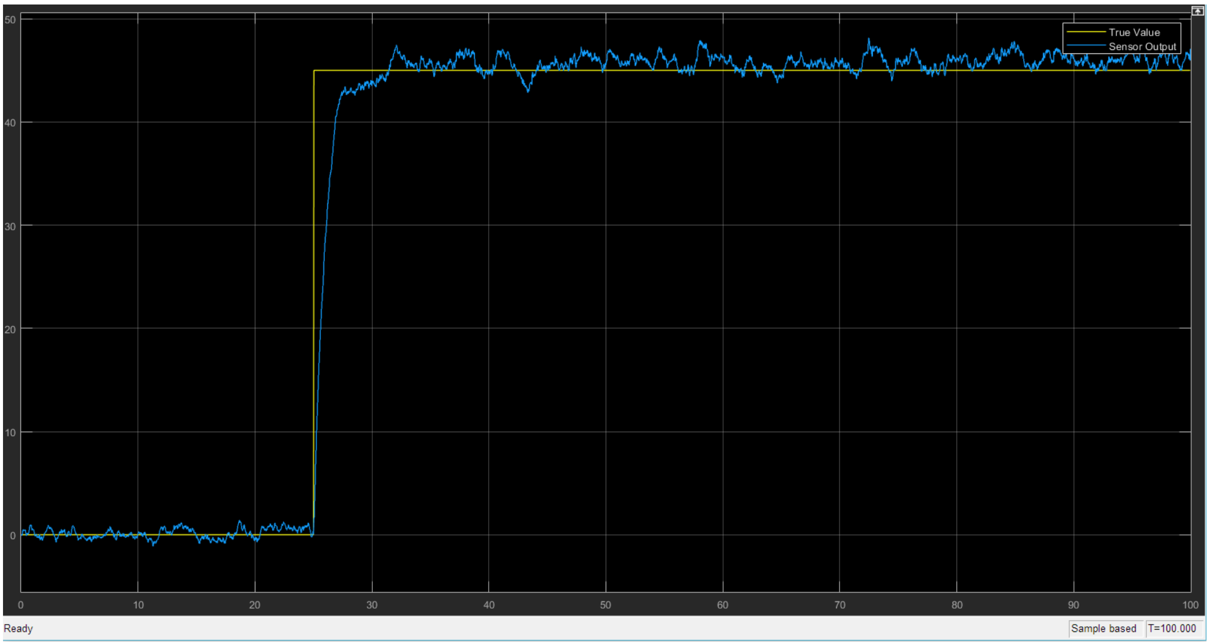
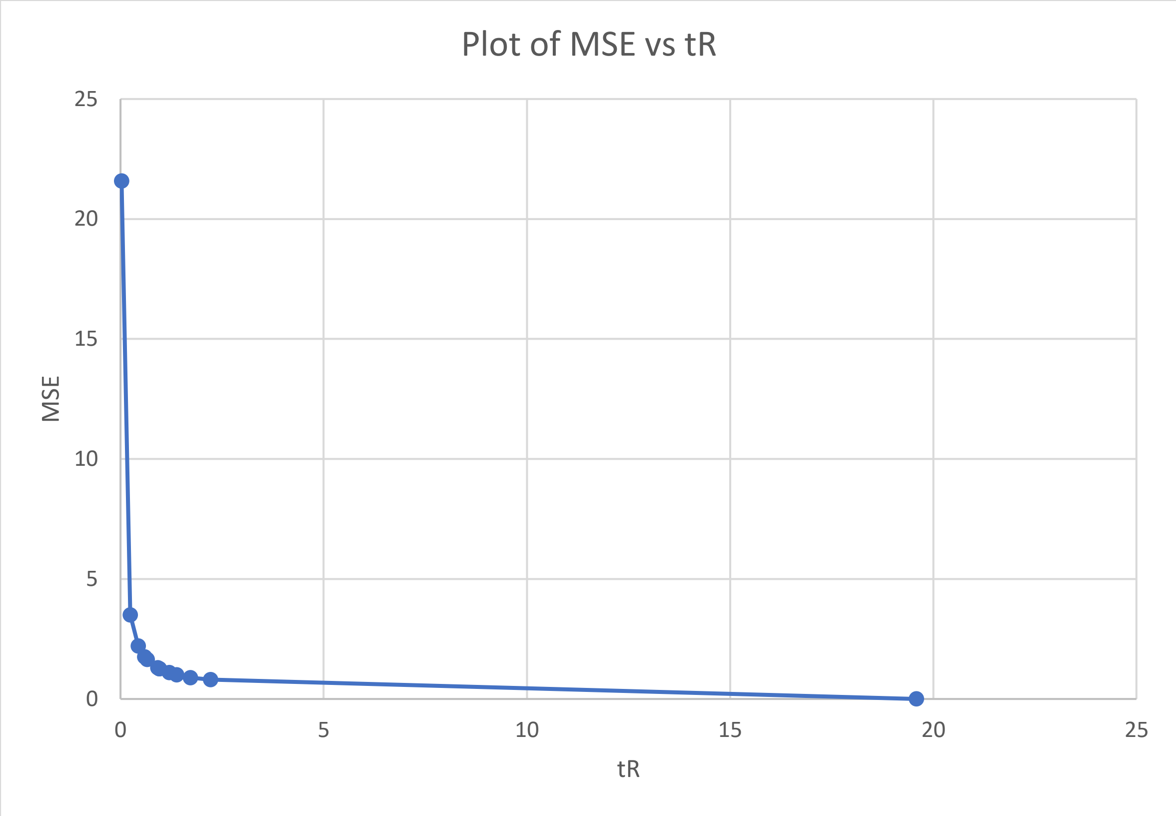
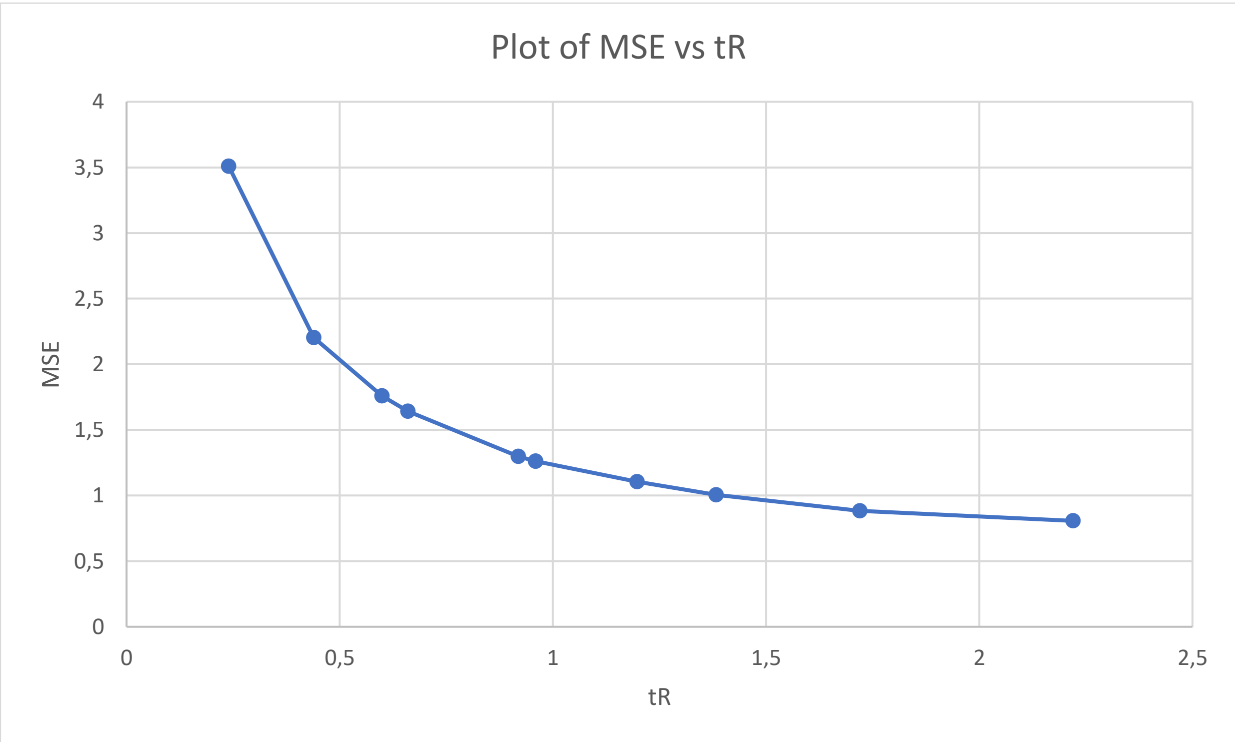


Figure 3: Sensor optimized for both MSE and rise time



Graph 1: Plot of MSE vs tR including A=0 and A=1



Graph 2: Plot of MSE vs tR excluding A=0 and A=1

A	tr (s)	mse (rad)	mag	ω (rad/s)
0	19.5886	0	19.5886	0.05
0.1	2.2197	0.8071	2.36188	0.4175
0.2	1.7197	0.883	1.933147	0.5486
0.3	1.3827	1.0055	1.709646	0.6931
0.39	1.1977	1.1051	1.629641	0.8111
0.4	0.9597	1.2612	1.584818	1.0148
0.45	0.9597	1.2612	1.584818	1.0148
0.5	0.9187	1.299	1.591041	1.0658
0.6	0.6597	1.6411	1.768732	1.5303
0.7	0.5987	1.7582	1.857339	1.6872
0.8	0.4387	2.2027	2.245962	2.2266
0.9	0.2397	3.5087	3.516878	3.942
1	0.0267	21.5811	21.58112	33.055

Thus, the value for omega, ω when the sensor has optimized for both MSE and rise time is

ω = **1.0148 rad/s**

APPENDIX:

```
function f = objectivefcn1(x)
% Variable to be optimized
omega = x;
sampleT = 0.001;
stopTime = 100;

% Run simulation
myobj = sim('noisyAccSensor','SrcWorkspace','Current');

% Grab simulation outputs
thT = myobj.get('thetaTrue');
thE = myobj.get('thetaEst');

 % ========= Calculate Rise Time ========
%tR =  %Rise Time calculation
N = length(thE); %samples
i63 =1;
thT_63 = 0.63*max(thT);
for i=1:N
   if (abs((thE(i) - thT_63)<0.001)) && (abs((thE(i)-(thT_63))< abs((thE(i63)-(thT_63)))))
      i63 = i;
```

```
  end
end
   t_63 = stopTime*i63/N;
tR = t_63 -25;

%disp(i63);
%disp(t_63);
%disp(tR);

 % ============ Calculate MSE ===========
% calculated after step when 'steady-state' has been reached
%mse = %MSE calculation
%steady state after 4*tR
tS = (floor((4*tR+25)*N/stopTime));
thT_S = thT(tS:N);
thE_S = thE(tS:N);
mse = (sum((thT_S-thE_S).^2))/(N-tS);

% ====== Create objective function =====
A=0;
disp(tR);
disp(mse);
f= A*tR +(1-A)*mse;
```