

1. The following Matlab code generates the required Table:

```

time=[0:1.e-4:4];
zeta=[0.9 0.95 1 1.3 1.5 1.7];
%zeta=[0.9:.01:1.8]; %Use this to get a more extensive table
table=[];
for k=1:length(zeta)
    y=step(tf(21.344,[1 9.24*zeta(k) 21.344]),time);
    t=find(y>=0.99);
    st=time(min(t));
    alpha=min(-real(roots([1 9.24*zeta(k) 21.344])));
    st1=4.62/alpha;
    if zeta(k)<0.9
        f=1;
    elseif zeta(k)>=0.9 & zeta(k)<1
        f=4.466*zeta(k)-3.024;
    elseif zeta(k)>=1 & zeta(k)<1.7
        f=0.008891/(zeta(k)-0.98)+1.0014;
    elseif zeta(k)>=1.7
        f=1;
    end
    st2=f*st1;
    table=[table;zeta(k) st st1 f st2 100*(st1-st)/st 100*(st2-st)/st];
end
fprintf('\n\nzeta Actual Ts 4.62/alpha f 4.62f/alpha PE_1 PE_2\n')
fprintf('%4.2f %8.3f %9.3f %8.2f %8.3f %7.0f %4.0f\n',table')

```

Here is the resulting Table:

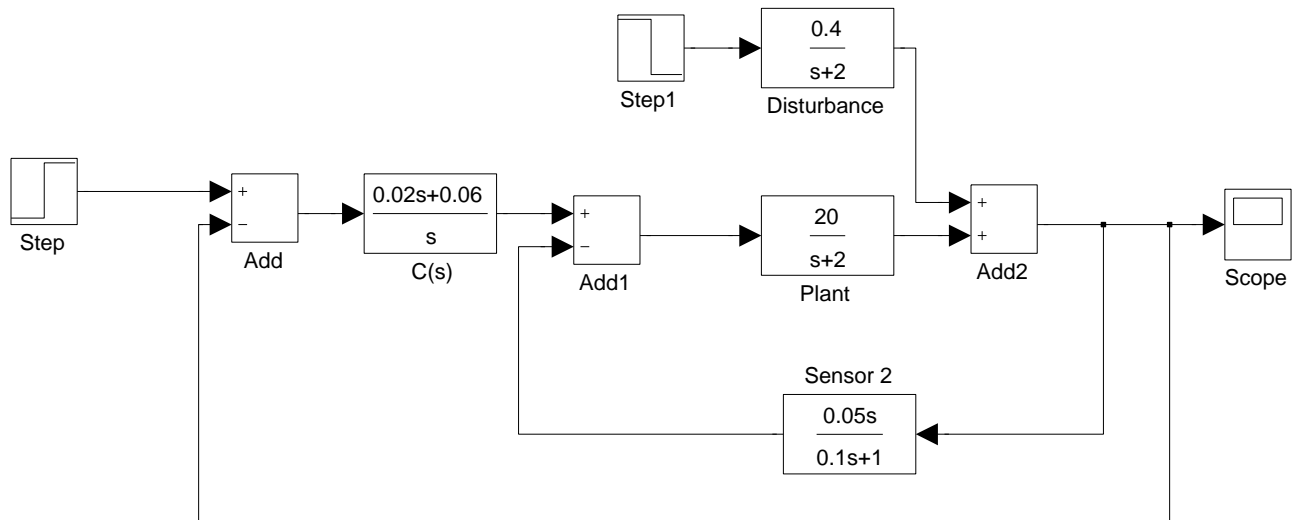
zeta	Actual Ts	4.62/alpha	f	4.62f/alpha	PE_1	PE_2
0.90	1.110	1.111	1.00	1.106	0	-0
0.95	1.273	1.053	1.22	1.283	-17	1
1.00	1.437	1.004	1.45	1.452	-30	1
1.30	2.239	2.131	1.03	2.193	-5	-2
1.50	2.699	2.618	1.02	2.667	-3	-1
1.70	3.139	3.075	1.00	3.075	-2	-2

Note that the simple formula has a maximum percent error of 30%, while the corrected formula has a maximum percent error of 2%. We can run the program with a much finer grid of ζ values. The results are about the same, except that the maximum error for the corrected formula is about 3%. Here is the extended table:

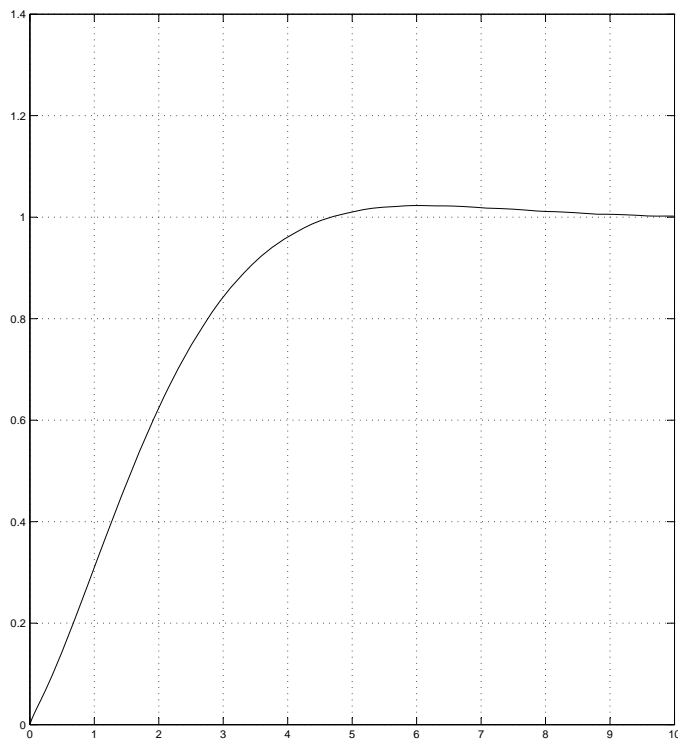
zeta	Actual Ts	4.62/alpha	f	4.62f/alpha	PE_1	PE_2
0.90	1.110	1.111	1.00	1.106	0	-0
0.91	1.142	1.099	1.04	1.143	-4	0
0.92	1.174	1.087	1.08	1.179	-7	0
0.93	1.207	1.075	1.13	1.214	-11	1
0.94	1.240	1.064	1.17	1.249	-14	1
0.95	1.273	1.053	1.22	1.283	-17	1
0.96	1.307	1.042	1.26	1.316	-20	1
0.97	1.340	1.031	1.31	1.348	-23	1
0.98	1.373	1.020	1.35	1.380	-26	1
0.99	1.405	1.010	1.40	1.411	-28	0
1.00	1.437	1.004	1.45	1.452	-30	1
1.01	1.469	1.152	1.30	1.495	-22	2
1.02	1.500	1.221	1.22	1.494	-19	-0
1.03	1.530	1.277	1.18	1.506	-17	-2
1.04	1.560	1.326	1.15	1.524	-15	-2
1.05	1.590	1.370	1.13	1.546	-14	-3
1.06	1.619	1.412	1.11	1.570	-13	-3
1.07	1.648	1.451	1.10	1.596	-12	-3
1.08	1.677	1.488	1.09	1.622	-11	-3
1.09	1.705	1.524	1.08	1.649	-11	-3
1.10	1.732	1.558	1.08	1.676	-10	-3
1.11	1.760	1.592	1.07	1.703	-10	-3
1.12	1.787	1.624	1.06	1.730	-9	-3
1.13	1.814	1.656	1.06	1.757	-9	-3
1.14	1.840	1.687	1.06	1.784	-8	-3
1.15	1.866	1.718	1.05	1.810	-8	-3
1.16	1.892	1.748	1.05	1.837	-8	-3
1.17	1.918	1.777	1.05	1.863	-7	-3
1.18	1.944	1.806	1.05	1.889	-7	-3
1.19	1.969	1.835	1.04	1.915	-7	-3
1.20	1.994	1.863	1.04	1.941	-7	-3
1.21	2.019	1.891	1.04	1.967	-6	-3
1.22	2.044	1.919	1.04	1.993	-6	-3
1.23	2.069	1.946	1.04	2.018	-6	-2
1.24	2.094	1.973	1.04	2.044	-6	-2
1.25	2.118	2.000	1.03	2.069	-6	-2
1.26	2.143	2.027	1.03	2.094	-5	-2
1.27	2.167	2.053	1.03	2.119	-5	-2
1.28	2.191	2.079	1.03	2.144	-5	-2
1.29	2.215	2.105	1.03	2.168	-5	-2
1.30	2.239	2.131	1.03	2.193	-5	-2
1.31	2.262	2.156	1.03	2.217	-5	-2
1.32	2.286	2.182	1.03	2.242	-5	-2

1.33	2.310	2.207	1.03	2.266	-4	-2
1.34	2.333	2.232	1.03	2.290	-4	-2
1.35	2.356	2.257	1.03	2.314	-4	-2
1.36	2.380	2.282	1.02	2.338	-4	-2
1.37	2.403	2.306	1.02	2.362	-4	-2
1.38	2.426	2.331	1.02	2.386	-4	-2
1.39	2.449	2.356	1.02	2.410	-4	-2
1.40	2.472	2.380	1.02	2.434	-4	-2
1.41	2.495	2.404	1.02	2.457	-4	-2
1.42	2.518	2.428	1.02	2.481	-4	-1
1.43	2.541	2.452	1.02	2.504	-3	-1
1.44	2.564	2.476	1.02	2.528	-3	-1
1.45	2.586	2.500	1.02	2.551	-3	-1
1.46	2.609	2.524	1.02	2.574	-3	-1
1.47	2.632	2.548	1.02	2.597	-3	-1
1.48	2.654	2.571	1.02	2.620	-3	-1
1.49	2.677	2.595	1.02	2.644	-3	-1
1.50	2.699	2.618	1.02	2.667	-3	-1
1.51	2.721	2.641	1.02	2.689	-3	-1
1.52	2.744	2.665	1.02	2.712	-3	-1
1.53	2.766	2.688	1.02	2.735	-3	-1
1.54	2.788	2.711	1.02	2.758	-3	-1
1.55	2.811	2.734	1.02	2.781	-3	-1
1.56	2.833	2.757	1.02	2.804	-3	-1
1.57	2.855	2.780	1.02	2.826	-3	-1
1.58	2.877	2.803	1.02	2.849	-3	-1
1.59	2.899	2.826	1.02	2.871	-3	-1
1.60	2.921	2.849	1.02	2.894	-2	-1
1.61	2.943	2.872	1.02	2.916	-2	-1
1.62	2.965	2.895	1.02	2.939	-2	-1
1.63	2.987	2.917	1.02	2.961	-2	-1
1.64	3.009	2.940	1.01	2.984	-2	-1
1.65	3.031	2.963	1.01	3.006	-2	-1
1.66	3.052	2.985	1.01	3.028	-2	-1
1.67	3.074	3.008	1.01	3.051	-2	-1
1.68	3.096	3.030	1.01	3.073	-2	-1
1.69	3.118	3.052	1.01	3.095	-2	-1
1.70	3.139	3.075	1.00	3.075	-2	-2

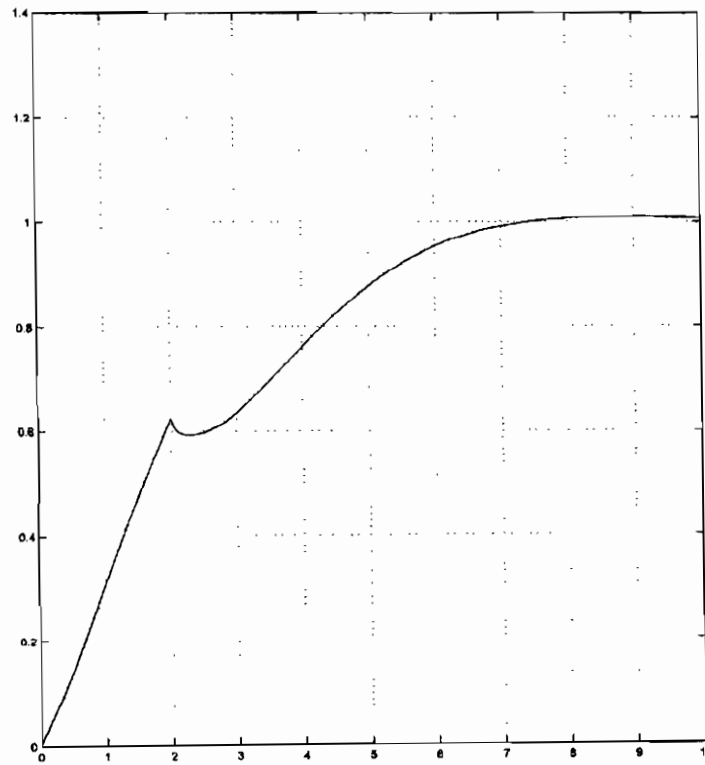
2. The Simulink block diagram is show below:



(a) When $r(t)$ is a unit step applied at time 0 and $r(t)$ is always zero, the plant output is:



(b) When $r(t)$ is a unit step applied at time 0 and $r(t)$ is a step of height -2 applied at time 2, the plant output is:



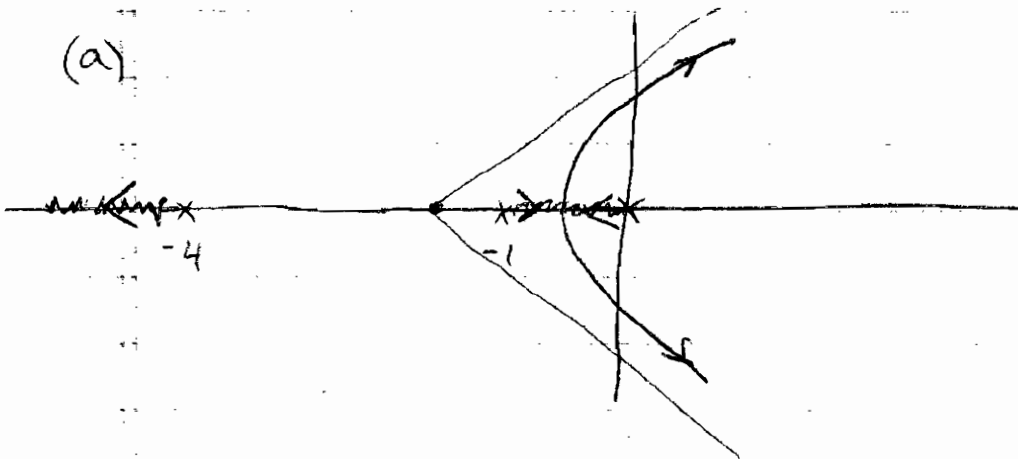
3.

$$n-m = 3$$

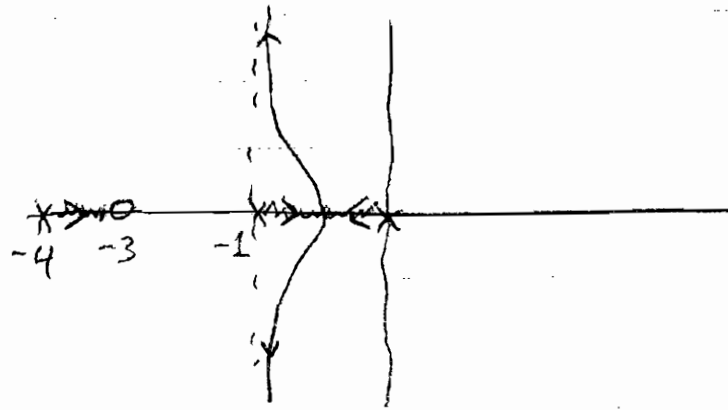
$$\sigma = -\frac{\sigma}{3}$$

angles 60, 180, 300

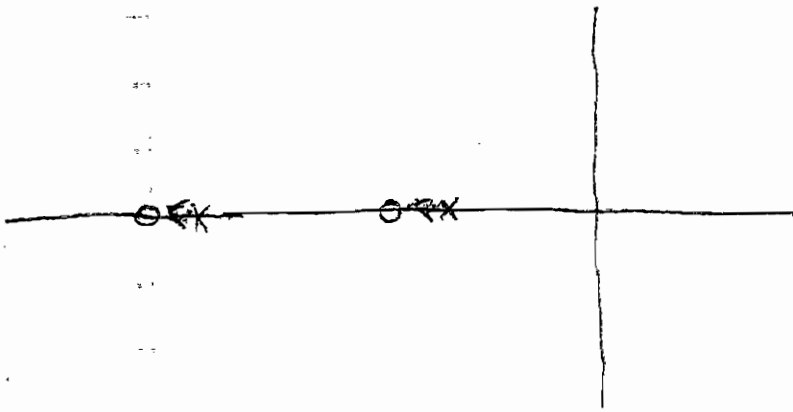
(a)



(b) $n-m = 2$ $\sigma = -1$ angles $90, 270$



(c) $n-m = 0$, no asymptotes



(d) $n-m = 2$ $\sigma = -2.25$ angles $90, 270$

