1.
(1)手算:

$$Y(z) = \frac{0.4z}{z^3 - 2.2z^2 + 1.9z - 0.7}$$

$$Y(z) = 2.2z^{-1}Y(z) - 1.9z^{-2}Y(z) + 0.7z^{-3}Y(z) + 0.4z^{-2}$$

$$y(k) = 2.2y(k-1) - 1.9y(k-2) + 0.7y(k-3) + 0.4\delta(k-2)$$

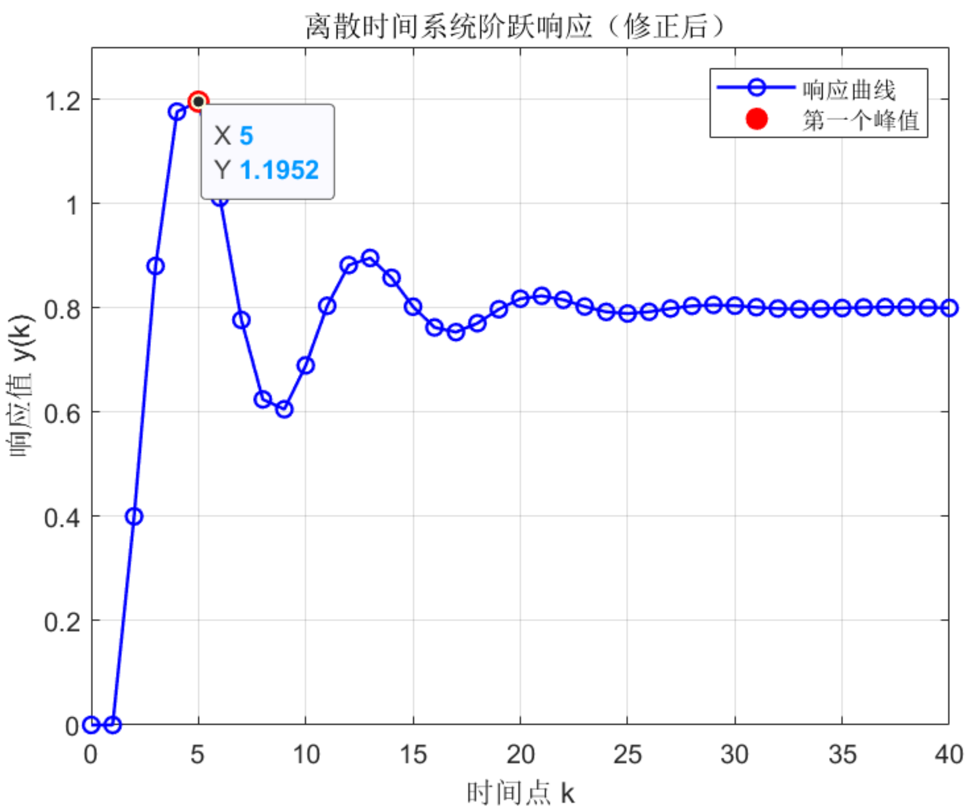
k	**y**
0	0
1	0
2	0.4
3	0.88
4	1.176
5	1.1952
6	1.01104
7	0.776608

所以首次峰值出现在$k = 5$时，$y(5) = 1.1952$
(2)MATLAB 验证:
代码:

```
num = [0.4 -0.4];
den = [1 -2.2 1.9 -0.7];

% 生成离散时间阶跃响应
k = 0:40;
y = dstep(num, den, length(k));

% 找到第一个峰值
[peaks, locs] = findpeaks(y);
if isempty(locs)
    disp('无峰值');
else
    first_peak_k = locs(1) - 1;
    fprintf('第一个峰值出现在 k = %d\n', first_peak_k);

    % 绘制阶跃响应曲线（折线图）并标记所有数据点
    figure;
    plot(k, y, 'b-o', 'LineWidth', 1.2, 'MarkerSize', 6);
    hold on;
    % 单独标记第一个峰值（红色填充）
    plot(first_peak_k, peaks(1), 'ro', 'MarkerFaceColor', 'r',
'MarkerSize', 8);
    hold off;

    % 设置图形属性
    title('离散时间系统阶跃响应（修正后）');
```

```
    xlabel('时间点 k');
    ylabel('响应值 y(k)');
    grid on;
    legend('响应曲线', '第一个峰值', 'Location', 'northeast');
    xlim([0, max(k)]);
    ylim([0, 1.3]);
    xticks(0:5:max(k));
end
```

生成 y(k)曲线:



与手算结果完全一致

2.

闭环特征方程为$D(z)=z^3-0.6z^2+0.08z+K=0$

(1) Bilinear transform & Routh-Hurwitz criteria

考虑变换$z=\frac{1+w}{1-w}$，得到$\left(\frac{1+w}{1-w}\right)^3-0.6\left(\frac{1+w}{1-w}\right)^2+0.08\left(\frac{1+w}{1-w}\right)+K=0$

化简得$(42-25K)w^3+(88+75K)w^2+(58-75K)w+(12+25K)=0$

根据劳斯判据：

w^3	$42-25K$	$58-75K$
w^2	$88+75K$	$12+25K$
w^1	$58-75K-\dfrac{(12+25K)(42-25K)}{88+75K}$	0
w^0	$12+25K$	

系统稳定条件：

$$\begin{cases}42-25K>0\\88+75K>0\\58-75K-\dfrac{(12+25K)(42-25K)}{88+75K}>0\\12+25K>0\end{cases}$$

解得：$0<K<\frac{\sqrt{101}-3}{10}=0.705$

(2) Jury criteria

1	1	-0.6	0.08	K
2	K	0.08	-0.6	1
3	$\begin{vmatrix}1 & K\\K & 1\end{vmatrix}=1-K^2$	$\begin{vmatrix}1 & 0.08\\K & -0.6\end{vmatrix}=-0.08K-0.6$	$\begin{vmatrix}1 & -0.6\\K & 0.08\end{vmatrix}=0.6K+0.08$	
4	$0.6K+0.08$	$-0.08K-0.6$	$1-K^2$	
5	$\begin{vmatrix}1-K^2 & 0.6K+0.08\\0.6K+0.08 & 1-K^2\end{vmatrix}=K^4-2.36K^2-0.096K+0.9936$	$\begin{vmatrix}1-K^2 & -0.08K-0.6\\0.6K+0.08 & -0.08K-0.6\end{vmatrix}=0.08K^3+0.648K^2+0.2864K-0.552$		
6	$0.08K^3+0.648K^2+0.2864K-0.552$	$K^4-2.36K^2-0.096K+0.9936$		
7	$\begin{vmatrix}K^4-2.36K^2-0.096K+0.9936 & 0.08K\text{^}3+0.648K\text{^}2+0.2864K-0.552\\0.08K^3+0.648K^2+0.2864K-0.552 & K^4-2.36K^2-0.096K+0.9936\end{vmatrix}$			

系统稳定条件：

$$\begin{cases}D(1)>0\\D(-1)<0\\1-K^2>0\\K^4-2.36K^2-0.096K+0.9936>0\\\begin{vmatrix}K^4-2.36K^2-0.096K+0.9936 & 0.08K^3+0.648K^2+0.2864K-0.552\\0.08K^3+0.648K^2+0.2864K-0.552 & K^4-2.36K^2-0.096K+0.9936\end{vmatrix}>0\end{cases}$$

解得：$0<K<\frac{\sqrt{101}-3}{10}=0.705$

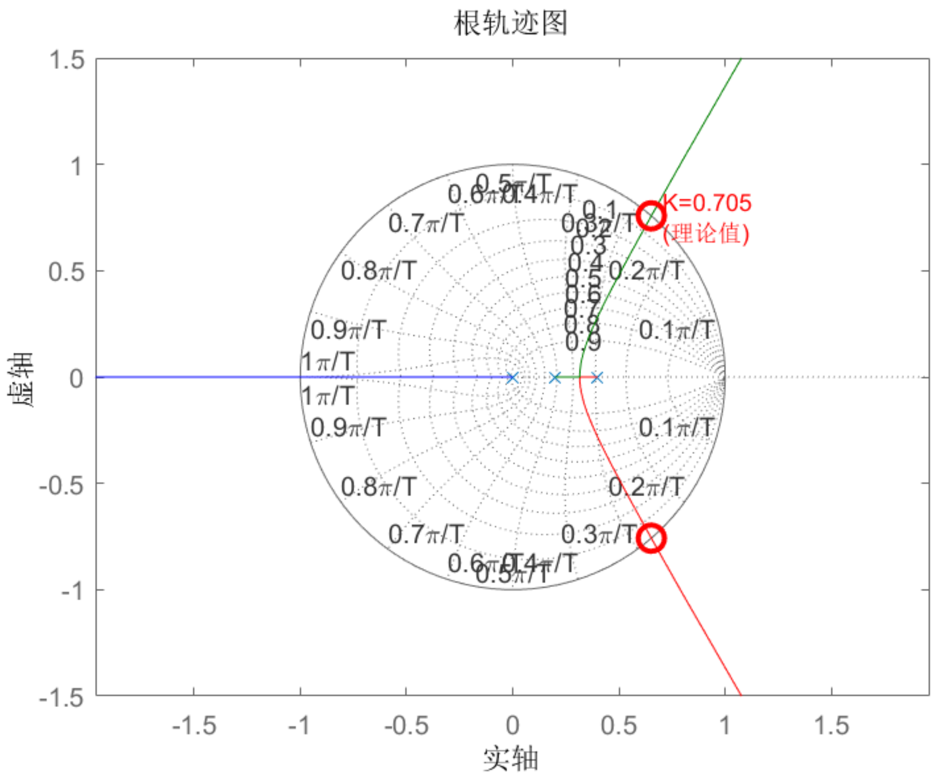
(3)

MATLAB 代码：

```
num = 1;
den = conv([1 0], conv([1 -0.2], [1 -0.4]));
G = tf(num, den, -1);

% 绘制根轨迹
```

```
figure;
rlocus(G);
hold on;
axis equal;
zgrid;
title('根轨迹图');
hold off;

% 使用 rlocfind 交互式获取临界 K 值
[K_critical, ~] = rlocfind(G);
```

运行结果:



$\therefore 0 < K < 0.705$与上述计算结果一致