

# DSP上机实验 MATLAB+MWORKS

感谢lsc,yxy,hyf完成本报告的代码部分

## DSP 上机实验 (MATLAB / MWorks / Julia)

本项目包含《数字信号处理》上机实验的 40 道题目，分别用 MATLAB 和 MWorks（基于 Julia 的科学计算环境）实现。每个题目都附有源代码、运行结果图以及详细的说明文档。

### 📁 项目结构

```
DSP上机实验/
| README.md # 本文件
| Readme.pdf # PDF 版本说明
|
|---Bitmap/ # 运行结果图 (MATLAB 与 Mworks 对比)
|   | MATLAB01.png
|   | MWORKS01.png
|   |
|   | ...
|
|---MATLAB/ # MATLAB 版本代码
|   | Src/ # 各题源代码 (.m 文件)
|   | 参考报告/ # 实验报告与汇总文档
|   | Matlab.md
|   | matlab上机完美版 11通信修订版.doc
|
|---Mworks/ # Mworks/Julia 版本代码
|   | DSP上机40题(Mworks).md # 汇总所有 Julia 代码
|   | DSP上机40题(Mworks).pdf
|
|---src/ # 各题源代码 (.jl 文件)
```

### 📊 实验题目列表

#### 1. 滤波器设计与群延时均衡

- 椭圆 IIR 低通 + 全通群延时均衡 (3阶/6阶)
- 巴特沃兹、切比雪夫、椭圆滤波器设计 (低通、高通、带通)
- Kaiser 窗、海明窗 FIR 滤波器设计
- 多频带 FIR 滤波器设计

#### 2. 系统分析与变换

- 部分分式展开
- 系统稳定性分析
- 零极点分布图绘制
- 级联型、并联型结构分解

- 格型结构系数计算

### 3. 信号处理与滤波

- 滑动平均滤波器
- 中值滤波器
- 重叠相加法滤波
- 总体均值滤波器

### 4. 变换与频谱分析

- 离散傅立叶变换 (DFT)
- 离散时间傅立叶变换 (DTFT)
- 复指数序列绘制
- 卷积计算 (时域与频域)

### 5. 信号生成与处理

- 指数序列、矩形序列生成
- 加性噪声模拟
- 包络分析
- 频响特性绘制

## 环境要求

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### MATLAB 版本

- MATLAB R2016b 或更高版本
- 需安装 Signal Processing Toolbox

### MWorks / Julia 版本

- [MWorks](#) 或 Julia 1.6+
- 需安装以下 Julia 包：
  - `DSP`
  - `TyPlot` (MWorks 内置)
  - `FFTW`
  - `Optim`
  - `LinearAlgebra`
  - `Statistics`
  - `Polynomials`
  - `SymPy`



## MATLAB

1. 进入 `MATLAB/Src/` 目录
2. 运行对应的 `.m` 文件, 如 `Question1.m`
3. 结果将显示在图形窗口, 部分结果输出到命令窗口

## MWorks / Julia

1. 进入 `Mworks/src/` 目录
2. 使用 MWorks 或 Julia 运行对应的 `.jl` 文件, 如 `Q1.jl`
3. 或直接打开 `DSP上机40题(Mworks).md` 在 MWorks 中逐题运行



`Bitmap/` 目录下包含了 MATLAB 与 MWorks 运行结果的截图, 可用于对比验证两种实现方式的一致性。



- `Matlab.md`: MATLAB 所有题目的代码汇总与说明
- `DSP上机40题(Mworks).md`: MWorks/Julia 所有题目的代码汇总与说明
- `matlab上机完美版 11通信修订版.doc`: 详细的实验报告与题目解析



- 每题均提供 MATLAB 与 MWorks/Julia 双版本实现
- 代码注释详细, 便于理解数字信号处理的基本原理
- 包含滤波器设计、系统分析、信号处理等多个 DSP 核心主题
- 可直接用于教学、实验或自学参考



本项目仅供学习交流使用, 遵循 MIT 许可证。请勿用于商业用途。



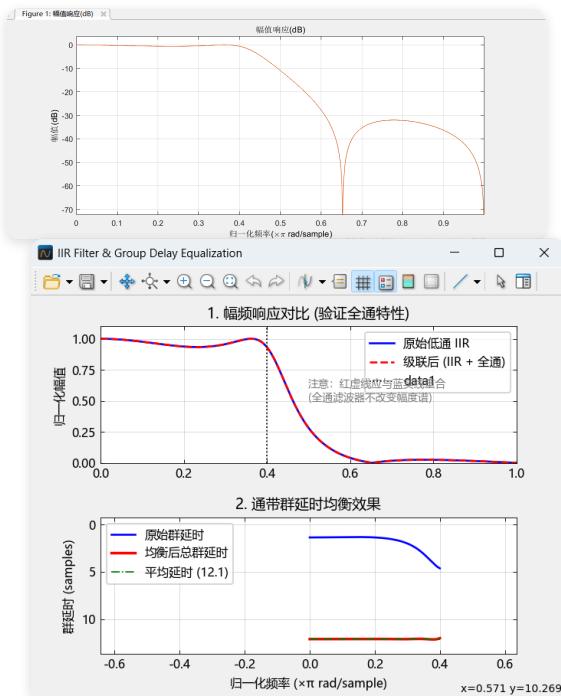
感谢数字信号处理课程教师与同学们的贡献, 以及 MATLAB 与 Julia 开源社区的支持。

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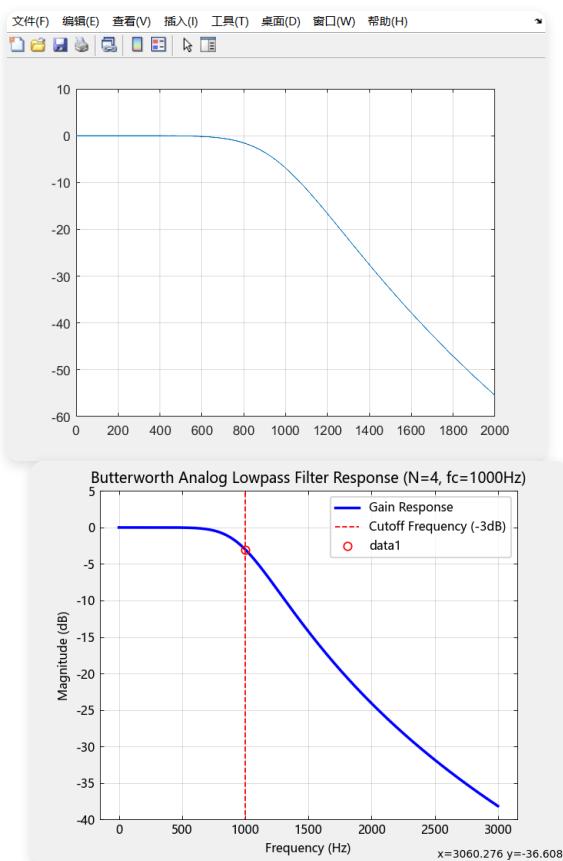
如果本项目对你有帮助, 欢迎 Star 和 Fork!

# MATLAB和MWORKS效果图对比

## Question 1



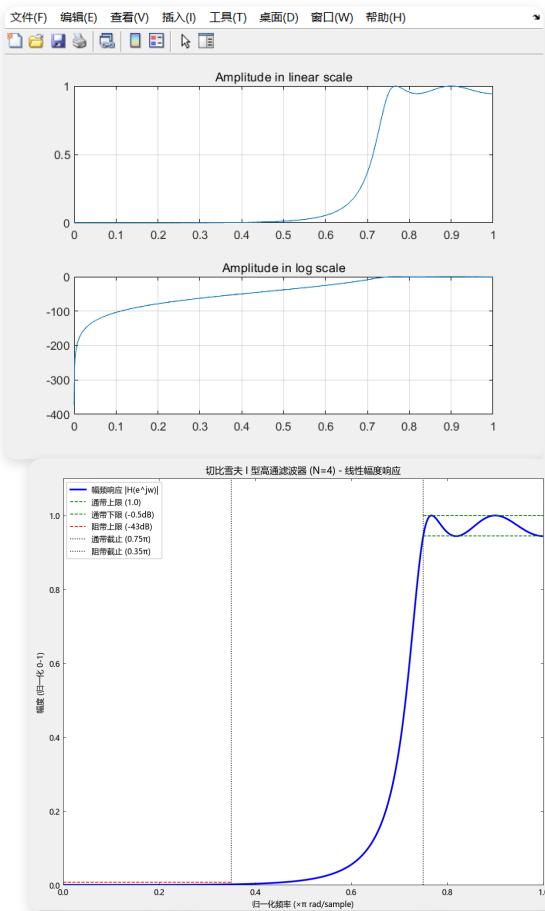
## Question 2



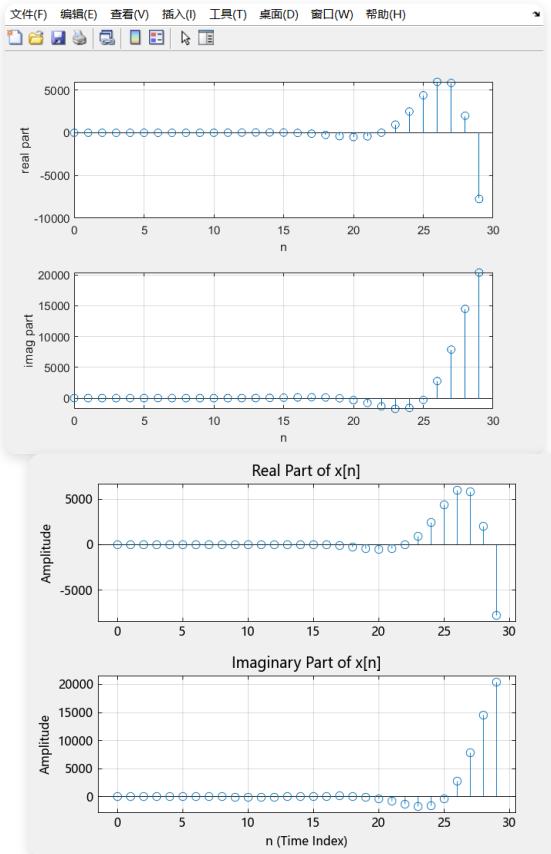
## Question 3

```
>> Question3
Residues
0.5776 + 0.00001i -0.7996 + 0.00001i -0.0676 + 0.0721i -0.0676 - 0.0721i
Poles
-2.2560 + 0.00001i -1.5871 + 0.00001i 0.3216 - 0.5363i 0.3216 + 0.5363i
Constants
0.3571
--- 部分分式展开 (复数形式) ---
H(z) =
+2.939522 +0.000000im / (1 - (-2.255978 +0.000000im) z^-1)
-2.014172 -0.000000im / (1 - (-1.587130 +0.000000im) z^-1)
+0.037325 -0.010012im / (1 - (0.321554 +0.536290im) z^-1)
+0.037325 +0.010012im / (1 - (0.321554 -0.536290im) z^-1)
```

## Question 4



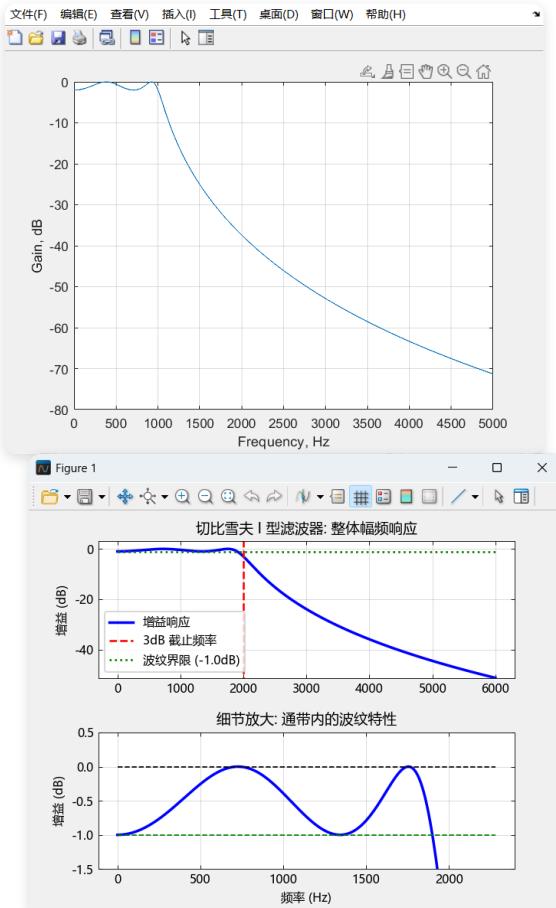
## Question 5



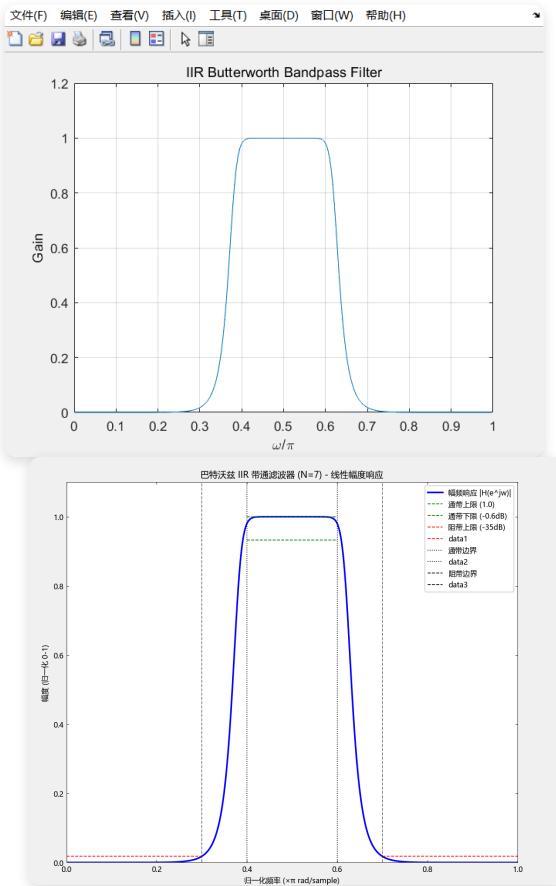
## Question 6

```
num =  
3.6000    1.1200   -0.7680    3.6864  
  
den =  
1.0000   -1.6000   -9.6000   18.4320  
  
.....计算结果.....  
原始表达式:  
0.2 + 1/(1 + 3.2/z) + 0.4/(1 - 2.4/z) + 0.3125/(0.4166666666666667 - 1/z)^2  
合并后的零极点图, H_rational(z):  
(0.625z^3 + 0.19545454545454544z^2 - 0.1333333333333333z + 0.04)/(0.1790111111111111z^3 - 0.2777777777777778z^2 - 1.666666666666667z + 3.2)  
.....分子与分母.....  
分子 M(z): 3.6z^3 + 1.12z^2 - 0.768z + 3.6864  
分母 D(z): 1.0z^3 - 1.6z^2 - 9.6z + 18.432
```

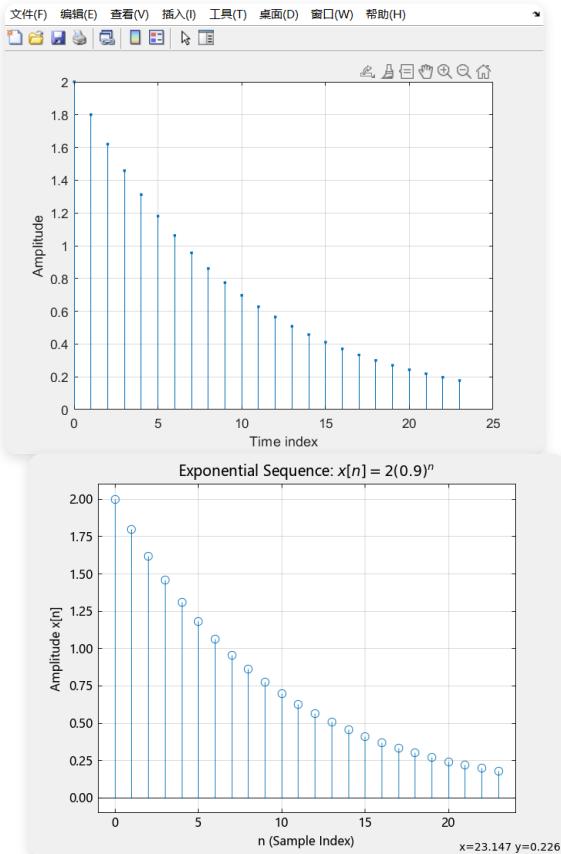
## Question 7



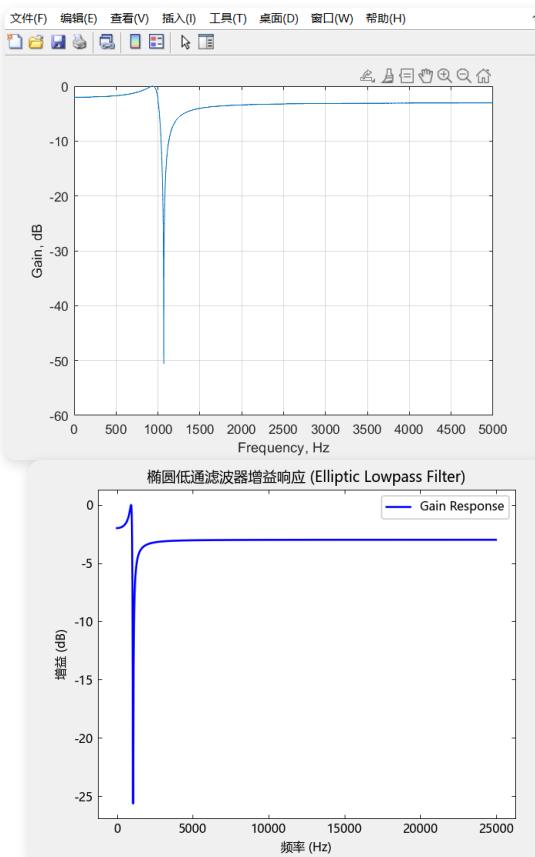
## Question 8



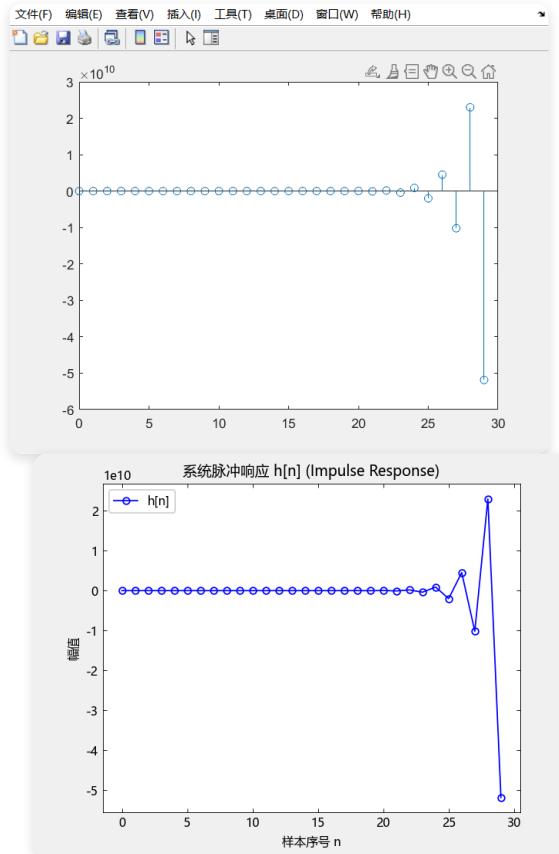
## Question 9



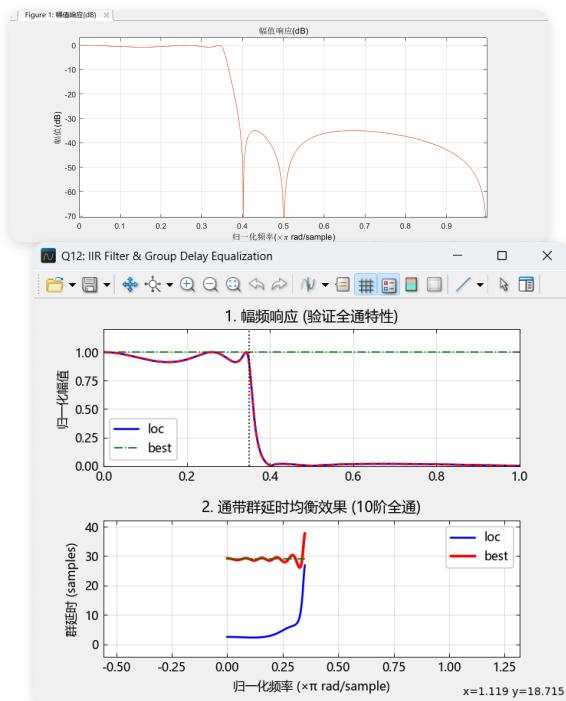
## Question 10



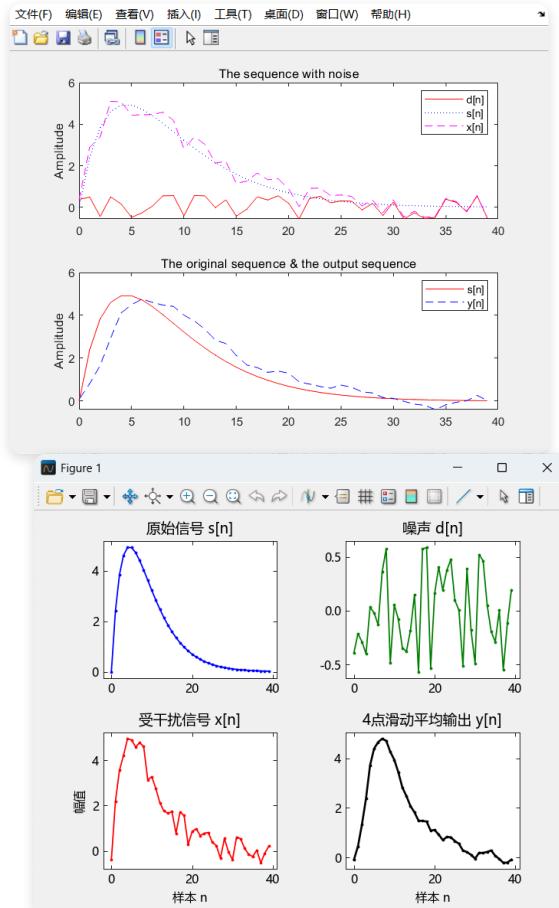
## Question 11



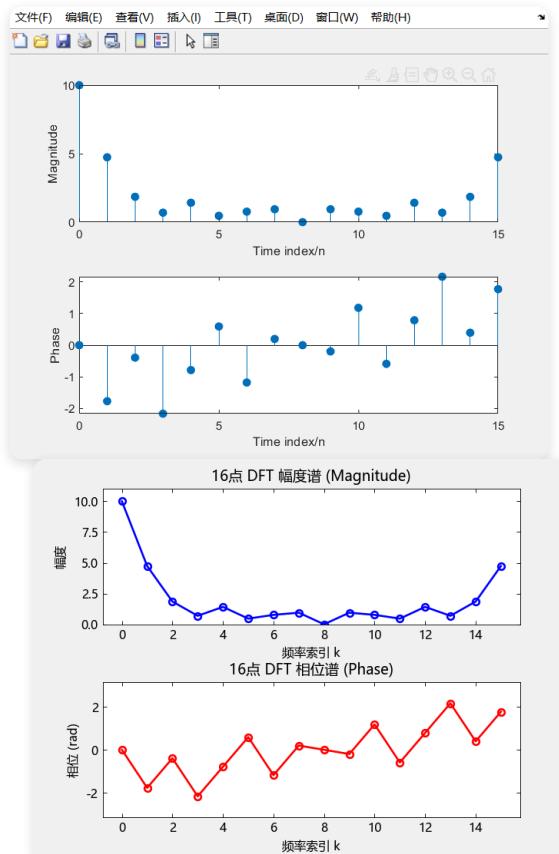
## Question 12



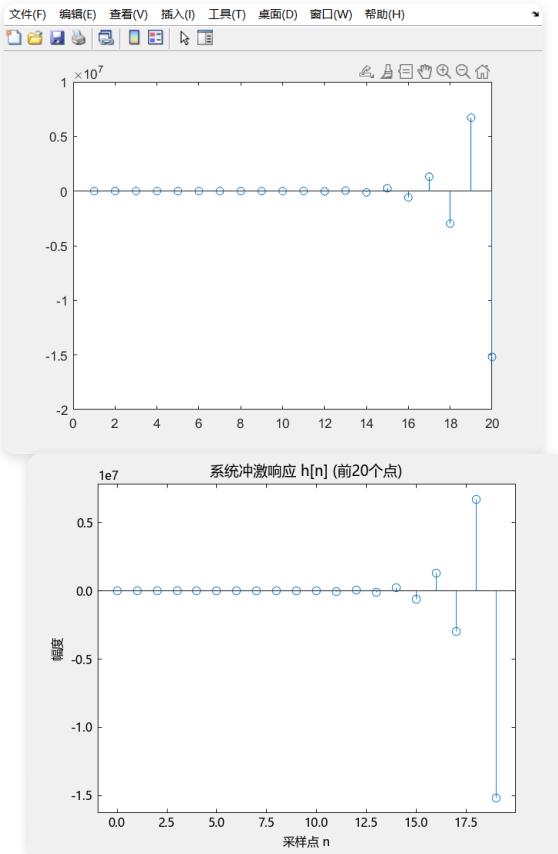
## Question 13



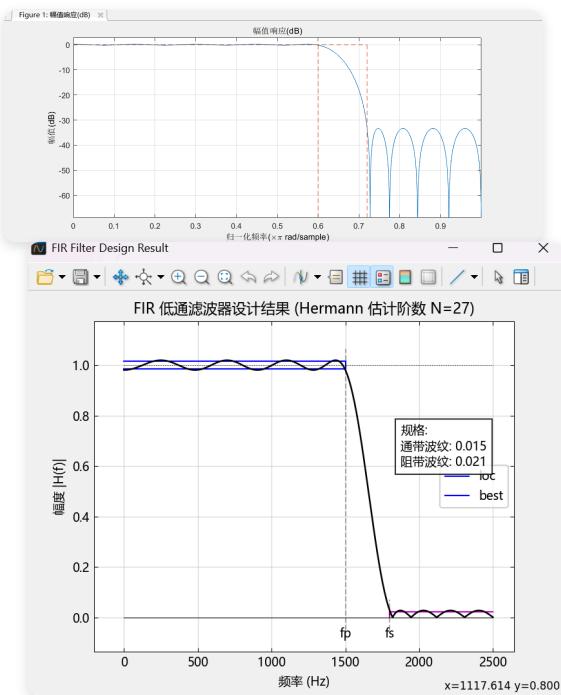
## Question 14



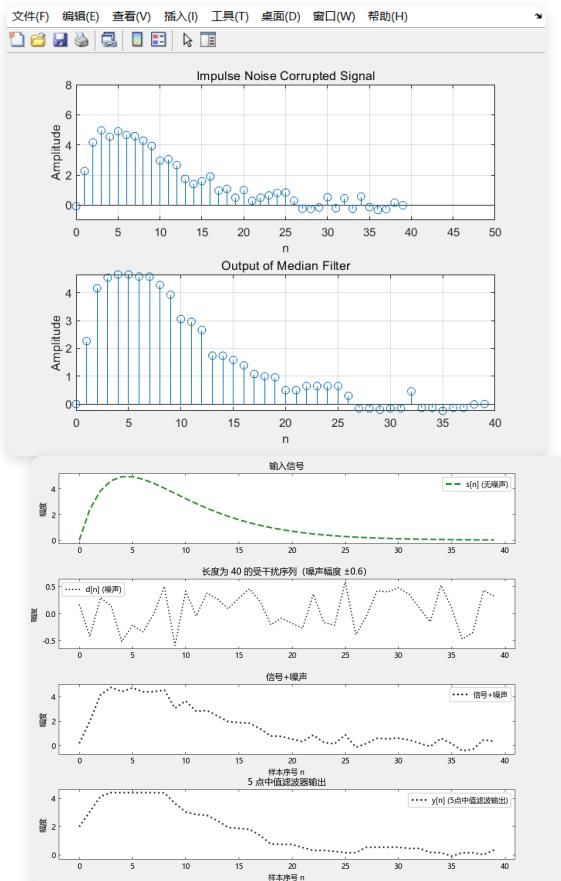
## Question 15



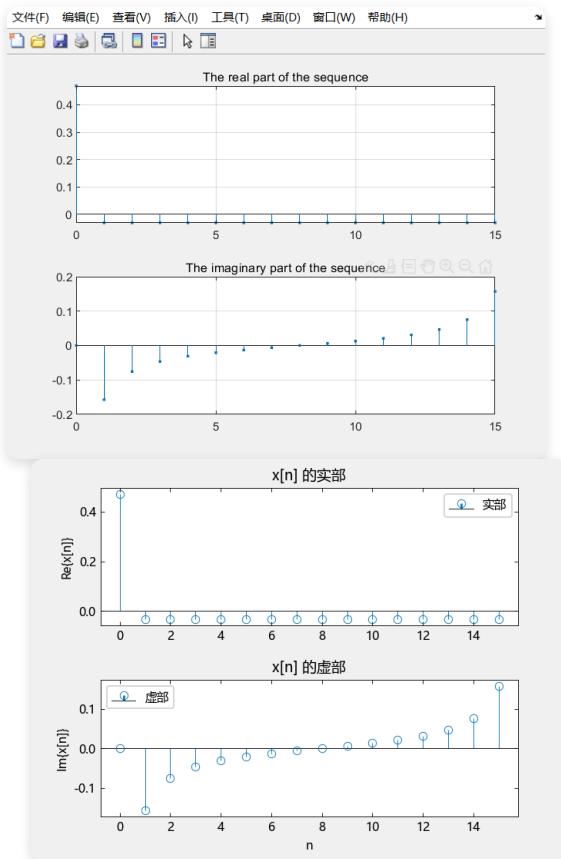
## Question 16



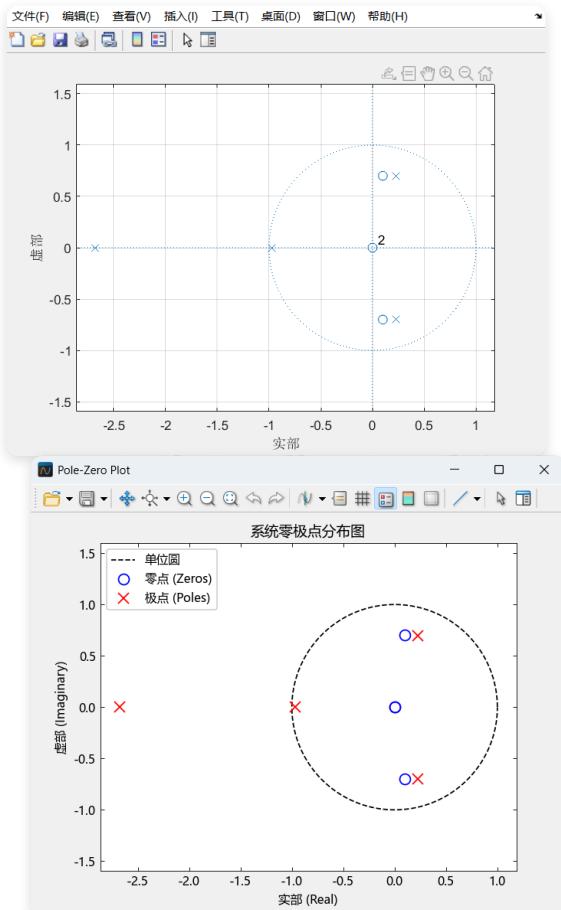
## Question 17



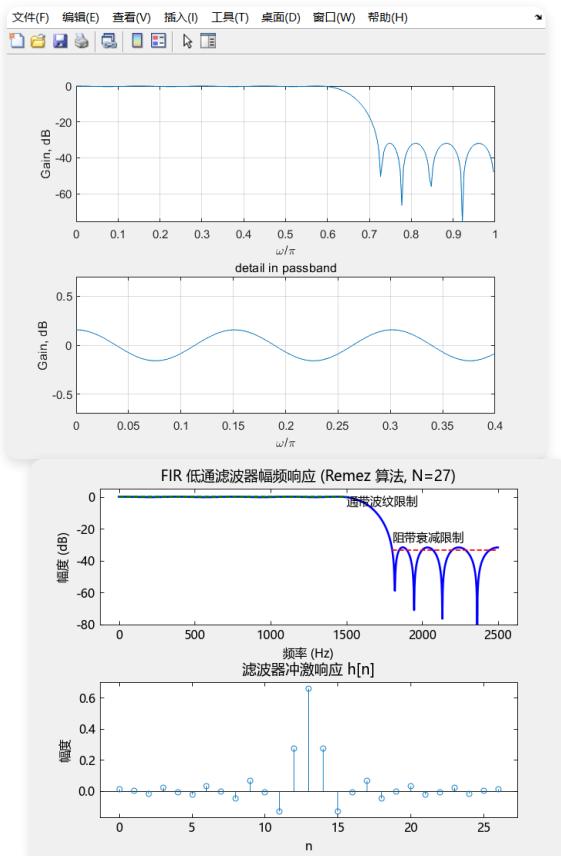
## Question 18



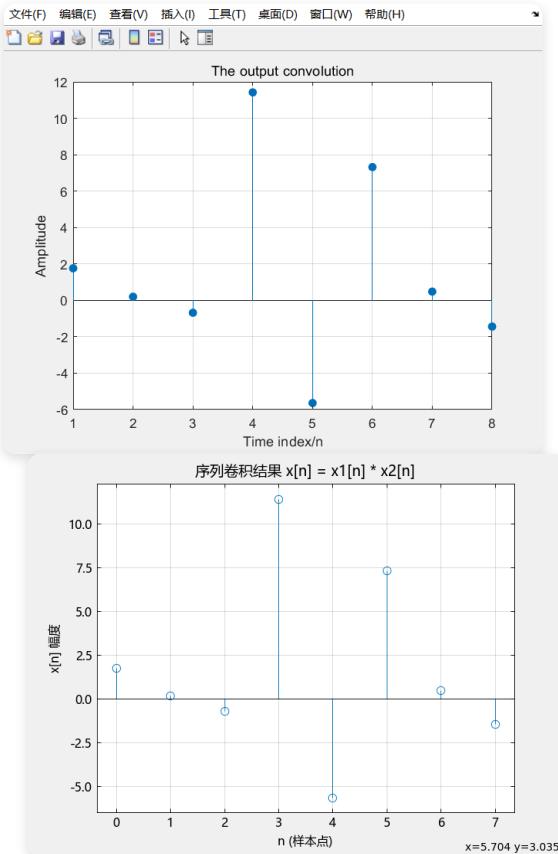
## Question 19



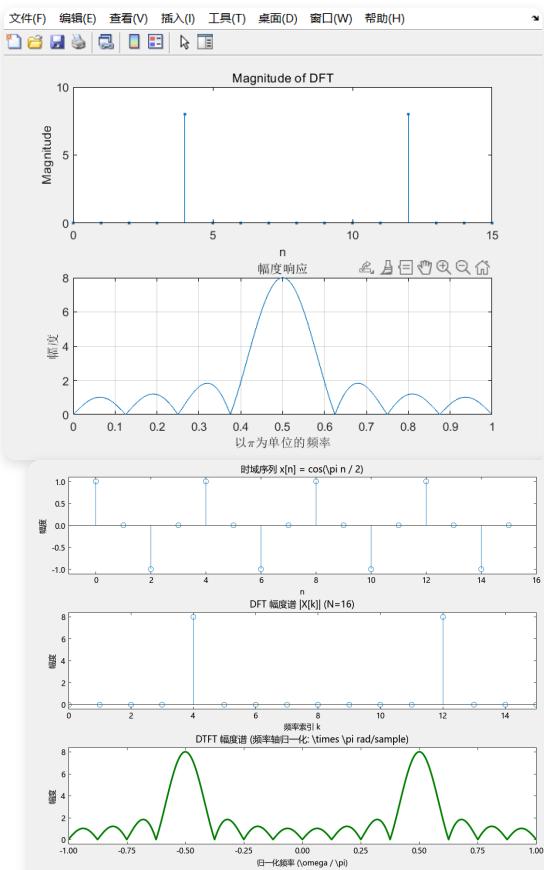
## Question 20



## Question 21



## Question 22

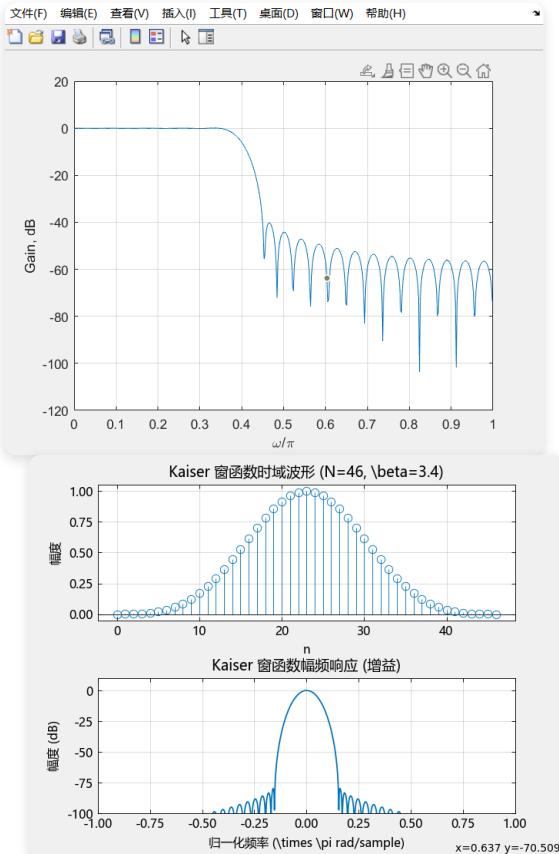


## Question 23

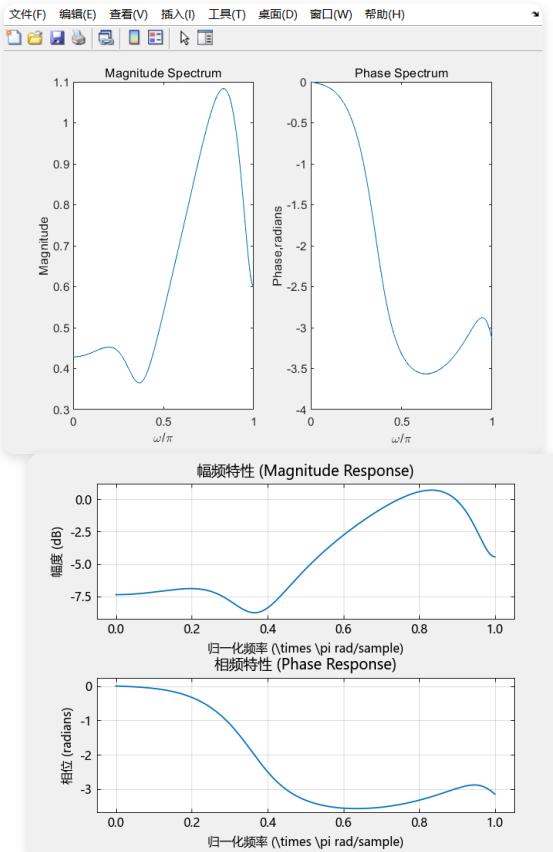
```
>> Question23
// 2 - 30760340995999097 z - 101075501475153163426986073413809 \ / 3 - 2568608038089949 z + 481818491299021132543532239475223 \
| z + 81129630441460668169579905144064 / \ z + 11258999906842824 324518553638426728783156020576256 \
\ \ 4503599627370498 4056491920730334084794502572028 / \
```

$$\begin{aligned}H1(z) &= 2.4000 + 5.4753z^{-1} + 3.5633z^{-2} \\H2(z) &= 1.0000 + 0.6830z^{-1} + 1.2459z^{-2} \\H3(z) &= 1.0000 - 1.6311z^{-1} + 1.1713z^{-2}\end{aligned}$$

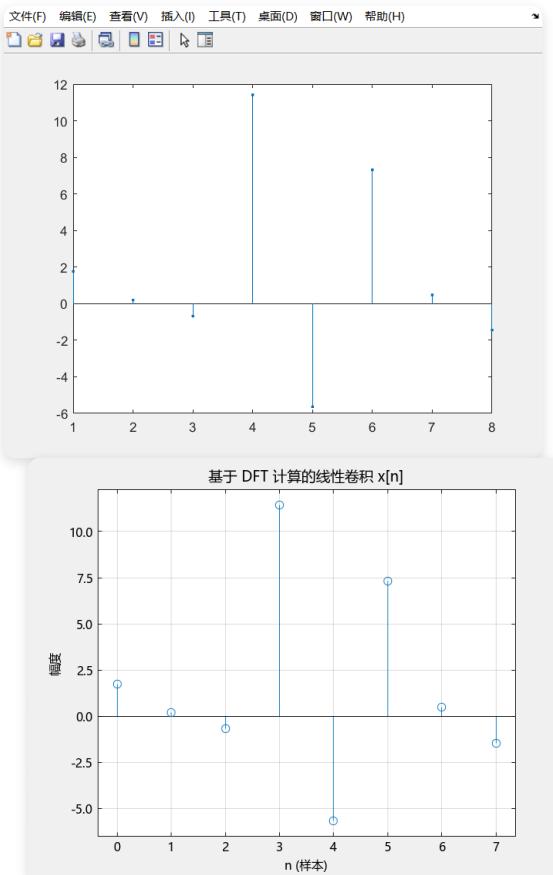
## Question 24



## Question 25



## Question 26



## Question 27

```
>> Question27

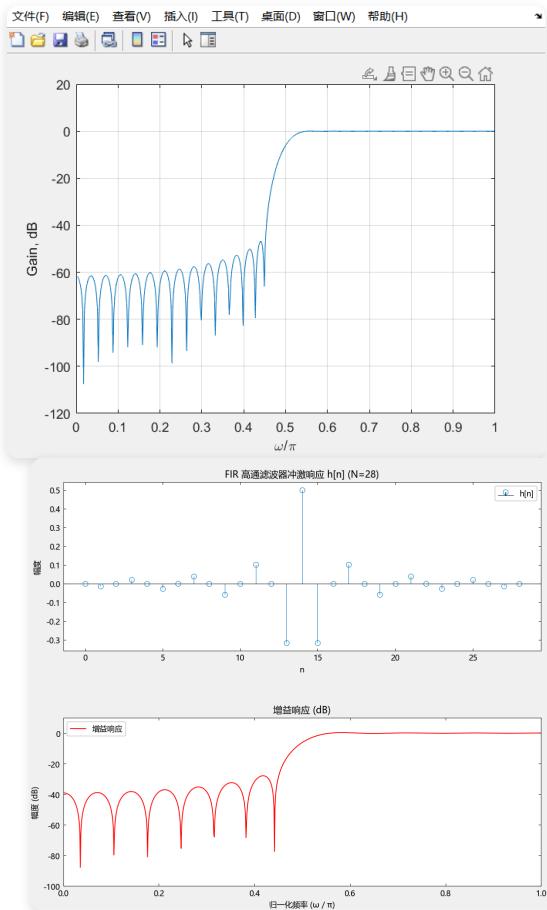
sos =
2.0000    3.0000      0    1.0000    4.3221      0
1.0000    2.5414    1.8159    1.0000   -1.8397    0.8397
1.0000   -1.5414    1.1014    1.0000    0.5176    0.8266

H_1(z) 分子: 1 +2.541393 z^-1 +1.815910 z^-2
分母: 1 +0.517635 z^-1 +0.826625 z^-2

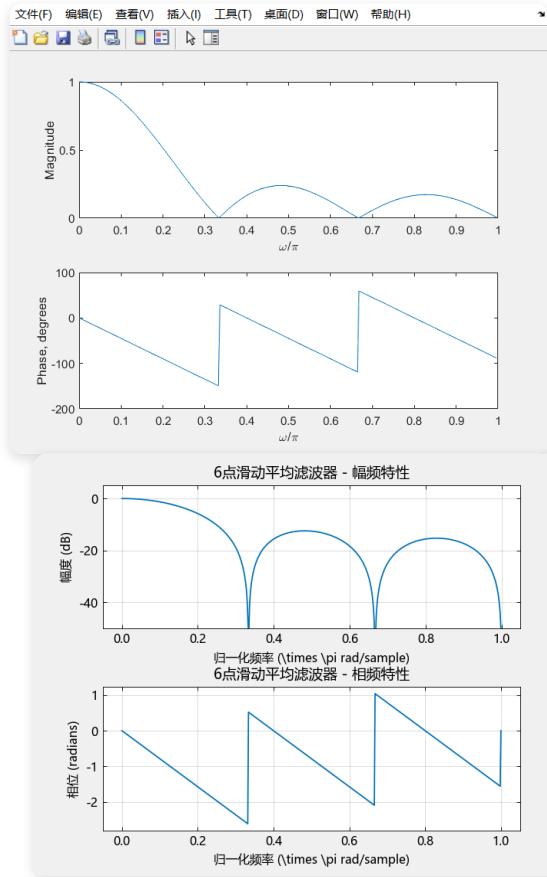
H_2(z) 分子: 1 -1.541393 z^-1 +1.101376 z^-2
分母: 1 +3.482365 z^-1 -3.629217 z^-2

H_3(z) 分子: 1 +1.500000 z^-1
分母: 1 -1.000000 z^-1
```

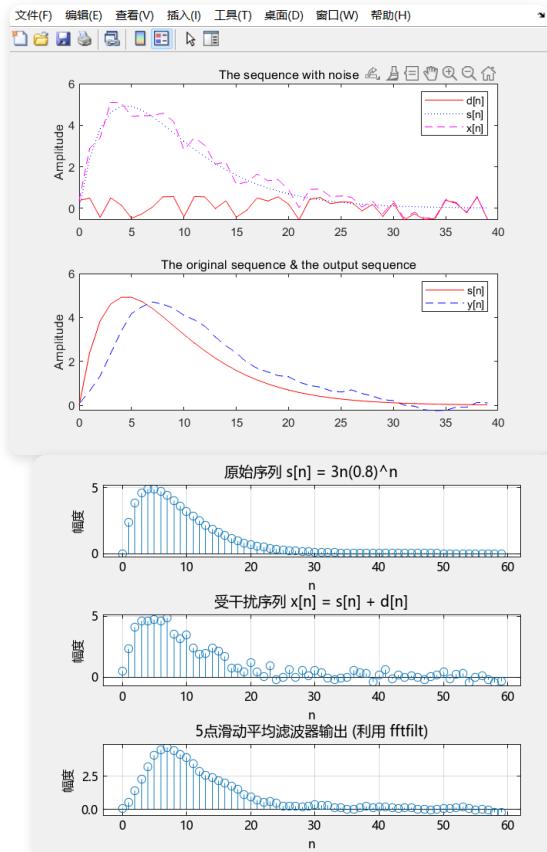
## Question 28



## Question 29



## Question 30



## Question 31

Parallel Form I 复数极点顶展开式分子系数

-0.0268 1.3353 0

Parallel Form I 复数极点顶展开式分母系数

1.0000 0.5176 0.8266

Parallel Form II 复数极点顶展开式分子系数

1.3491 0.0221

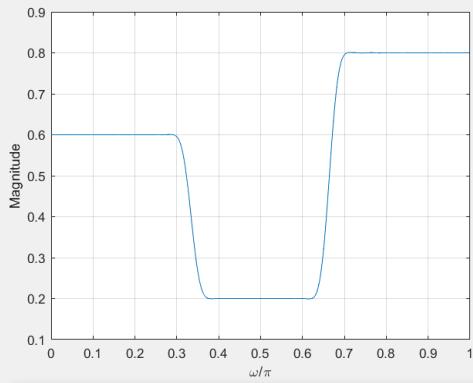
Parallel Form II 复数极点顶展开式分母系数

1.0000 0.5176 0.8266

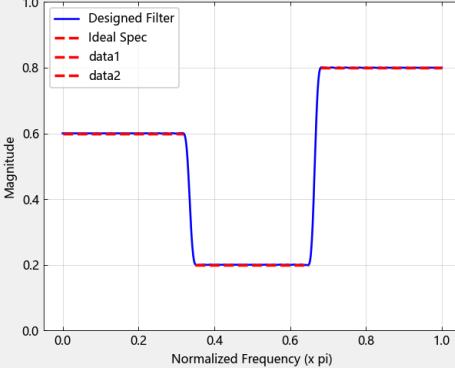
```
julia> 正在运行 Q31.jl
Parallel Form I (complex):
k = 5
r[1] = 0.30053582302316617 - 0.4553854139616695im , p[1] = -0.3925566621973104 + 0.5995596238762573im
r[2] = 0.3005358230231661 + 0.4553854139616695im , p[2] = -0.3925566621973104 - 0.5995596238762574im
r[3] = -0.2475932957627625 + 0.271856798679928im , p[3] = 0.19995503116918681im + 1.19995503116918681im
r[4] = -0.2475932957627625 - 0.271856798679928im , p[4] = 0.19995503116918681im - 1.19995503116918681im
r[5] = 7.500000000000054 + 1.4498113041588858e-14im , p[5] = 0.9999999999999991 - 2.101175803128928e-16im
Parallel Form II (real SOS):
section: (0.6010716404063323 + 0.78205192631980999 z^-1) / (1 + 0.7851113324394621 z^-1 + 0.513619660033766 z^-2)
section: (-0.4945865955135525 + -0.5819013905272774 z^-1) / (1 - 0.2851113324394613 z^-1 + 1.460224478071374 z^-2)
section: 7.500000000000054 / (1 - 0.9999999999999991 - 2.101175803128928e-16)
```

## Question 32

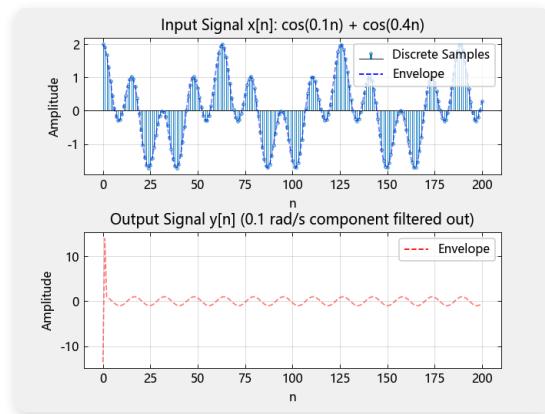
文件(F) 编辑(E) 查看(V) 插入(I) 工具(T) 桌面(D) 窗口(W) 帮助(H)



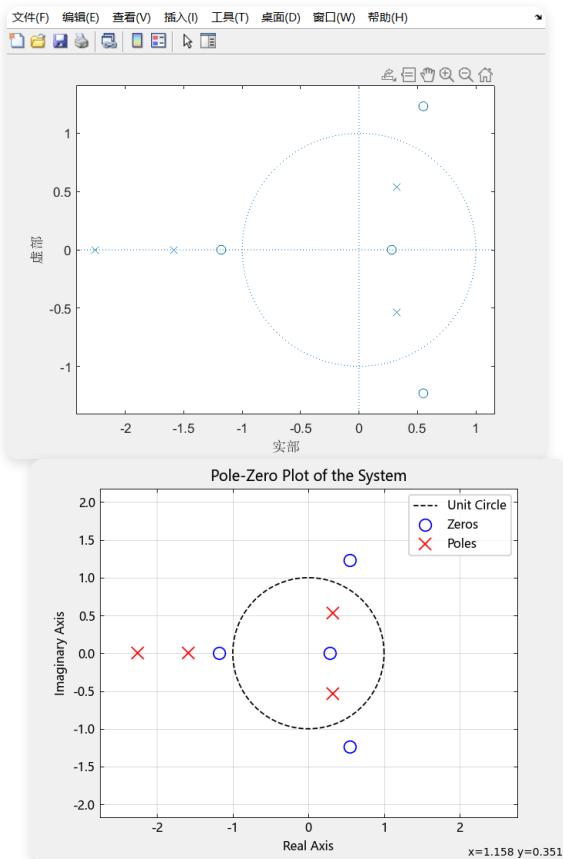
Frequency Response of Multiband FIR Filter (Hamming Window)



## Question 33



## Question 34



## Question 35

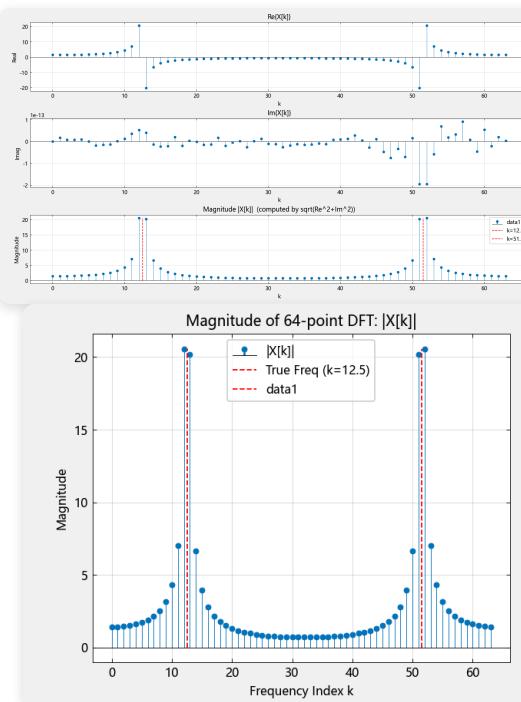
>> Question34

0.3574

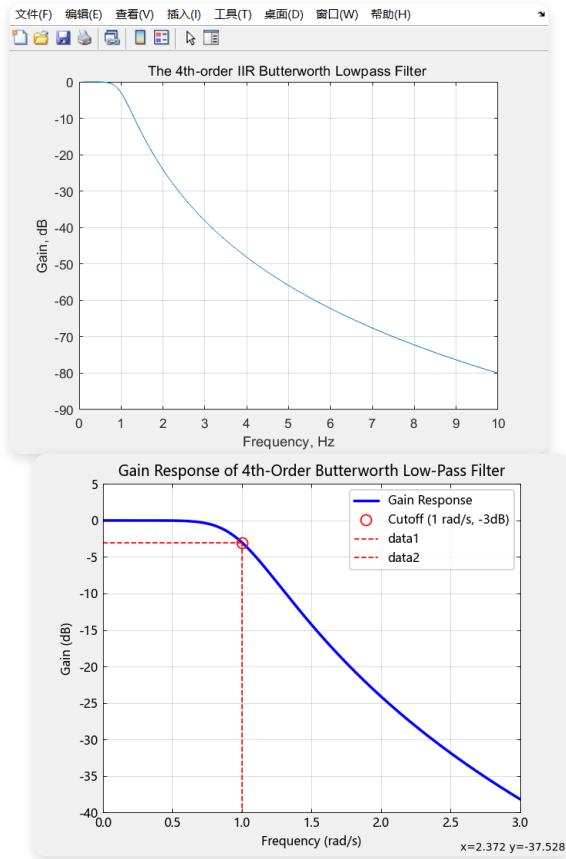
0.2708

-0.2000

## Question 36



## Question 37



## Question 38

```
>> Question38
Numerator polynomial coefficients
1.000000000000000 -1.600000000000000 -2.120000000000000 -1.040000000000000 6.160000000000000

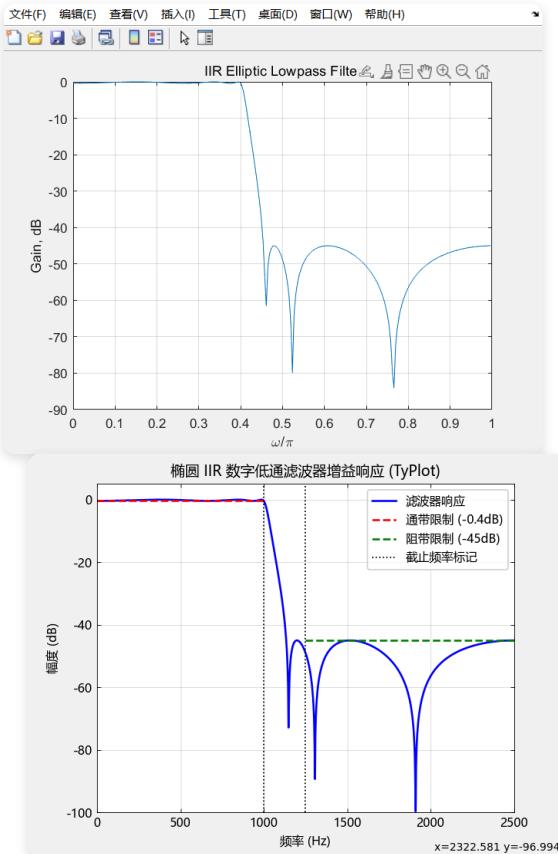
Denominator polynomial coefficients
1.000000000000000 -3.200000000000001 -7.980000000000002 34.264000000000003 95.702900000000000

[分子系数 b]:
[1.0, -1.6, -2.12, -1.04, 6.16]

[分母系数 a]:
[1.0, -3.2, -7.98, 34.264, 95.7029]

数学表达式 H(z):
H(z) = ( 1 -1.6000 z^-1 + -2.1200 z^-2 + -1.0400 z^-3 + 6.1600 z^-4 )
----- ( 1 -3.2000 z^-1 + -7.9800 z^-2 + 34.2640 z^-3 + 95.7029 z^-4 )
```

## Question 39



## Question 40

