

1. Upload: .m file, .fig file and .doc report. The report should be written in English.

2. Pack all the above files. The format of pack name: Lab8_ID_Name.zip, X is the experiment number.

3. For each answer, copy the relevant codes.

4. All the figure should have x/y label and legend for each line.

Complete the following tasks: 100 points in total.

1. Consider the following 4-by-4 unitary matrix: (30 points)

$$\mathbf{A} = \begin{bmatrix} 1 & 2+i & 1 & 1+i \\ 1 & i & e^{-i\pi} & 1 \\ 1 & e^{-i\pi} & e^{-i2\pi} & e^{-i3\pi} \\ 1 & 1+3i & e^{-i3\pi} & e^{-i\frac{9\pi}{2}} \end{bmatrix}$$

(1) Calculate the real part, image part, amplitude, and angle of each element on the second column. (10 points)

(2) Calculate the sum of all the entries on the fourth row. (10 points)

(3) Calculate $\mathbf{A}\mathbf{A}^T$ and $\mathbf{A}^T\mathbf{A}$, respectively. (10 points)

2. Consider the following AM signal:

$$s(t) = A_c m(t) (\cos(2\pi f_1 t) + \cos(2\pi f_2 t))$$

where $A_c = 1$, $m(t) = \sin(2\pi t)$, $f_1 = 10$, $f_2 = 5$, $0 \leq t \leq 2$. Sampling rate **fs=200Hz**. (40 points)

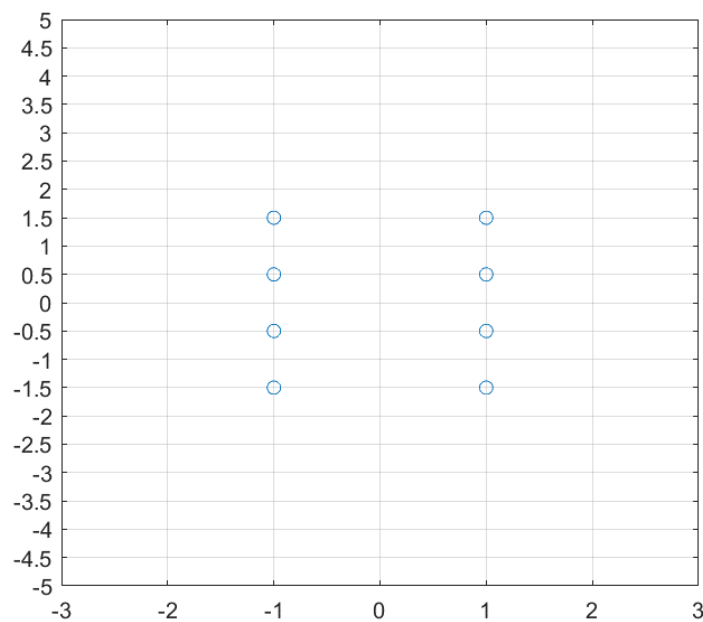
(1) Plot the signal in the time domain and its magnitude spectrum, **explain**

the resulted spectrum. (20 points)

(2) Calculate the energy and power of the signal **from 0s to 2s, in time domain. (10 points)**

(3) The signal is passing through a noiseless bandlimited ‘channel’, whose response is **$H(f)=1, |f| \leq 5\text{Hz}$ and $H(f)=0$, otherwise.** Plot the resulted signal in the time domain. Compare with the original signal and **explain your results (10 points)**

3. Consider the 8QAM modulation with the following constellation diagram. (30 points)



$$u_m(t) = A_{mc}g_T(t)\cos 2\pi f_c t + A_{ms}g_T(t)\sin 2\pi f_c t, \quad m = 1, 2, \dots, M$$

$$g_T(t) = \begin{cases} \sqrt{\frac{2}{T}}, & 0 \leq t \leq T \\ 0, & \text{otherwise} \end{cases}, \text{ and } T=1$$

- (1) Calculate the average energy per symbol and per bit of 8QAM, respectively. (10 points)
- (2) Simulate the **symbol error rate** of 8QAM under SNR-per-bit=0dB. (10 points)
- (3) Plot the received constellation diagram after the 8QAM signals pass through the AWGN channel under SNR-per-bit=0dB and 20dB, respectively, **explain your results**. (10 points)