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 DFT matrix: (30 points)

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

(1) Calculate the real part, image part, amplitude, and angle of **each element on the third row**. (10 points)

(2) Calculate the **sum of all the entries on the second column**. (10 points)

(3) Verify the orthogonality of **A**, i.e.,(H 共轭转置)

$AA^H=A^HA=I$, where **I is identity matrix**. (10 points)

2. Consider the following AM signal:

$$s(t) = A_c m(t)\cos(2\pi f_c t)$$

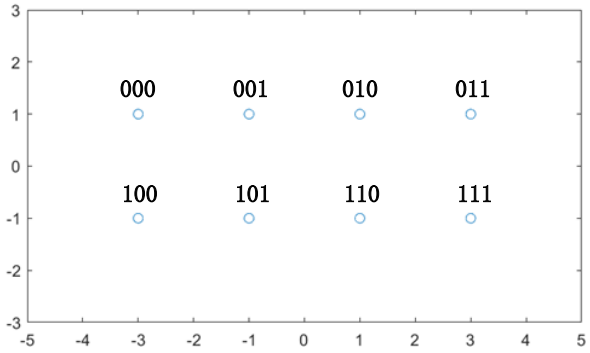
where $A_c = 1$, $m(t) = \cos(2\pi t) + \sin(\pi t)$, $f_c = 10$, $0 \le t \le 4$.
Sampling rate **fs=100Hz**. (40 points)

(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 4s**, **in time domain.** (10 points)

(3) The signal is passing through a noiseless bandlimited 'channel', whose response is **H(f)=1, |f|⩽2Hz 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)



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

$$g_T(t) = \begin{cases} \sqrt{\frac{2}{T}}, & 0 \le t \le T \\ 0, & \text{otherwise} \end{cases}$$, 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 10dB, respectively, **explain your results**. (10 points)