※ 考生請注意：本試題不可使用計算機。 請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. (10%) If we have the Fourier transform pair $x[n]$ and $X(e^{j\omega})$, please express the Fourier transform of

$$y[n] = \frac{x[n] - x^*[-n]}{2}$$

in terms of $X(e^{j\omega})$.

2. (10%) Find and sketch the inverse Fourier transform of

$$X(j\omega) = \text{sinc}^2\left(\frac{\omega}{2\pi}\right).$$

3. (10%) Please find the inverse Fourier transform of

$$X(j\omega) = \frac{1}{(2 + j\omega)^3}.$$

4. (15%) Please find

$$\text{sinc}\left(\frac{t}{4}\right) * \text{sinc}\left(\frac{t}{2}\right) = \ ?$$

5. (10%) Let $X(j\omega)$ be the spectrum of the signal $x(t) = \pi \cdot u(t - 2) - \pi \cdot u(-t - 2)$. Find $X(j0)$.

6. (10%) Please find the Fourier transform of

$$x(t) = \ \text{rect}\left(\frac{t}{T}\right) \cdot \cos(\omega_c t)$$

where

$$\text{rect}\left(\frac{t}{T}\right) = \begin{cases} 1, & t \le \left|\frac{T}{2}\right| \\ 0, & \text{elsewhere.} \end{cases}$$

7. (15%) Consider the cascade of two linear time-invariant (LTI) systems with impulse responses $h_1[n] = e^{\cos(\pi n^6)}$ and $h_2[n] = e^{-2018n}u[n]$. Please find the output $y[n] = h_2[n] * h_1[n] * x[n]$ if the input $x[n] = e^{2018}\delta[n] - \delta[n - 1]$.

8. (20%) For a discrete-time LTI system with the impulse response $h[n]$, show that this LTI system is bounded-input bounded-output (BIBO) stable if and only if

$$\sum_{k=-\infty}^{\infty} |h[k]| < \infty.$$