# Fourier Analysis    N=6, $\longrightarrow$

Calculating weights,
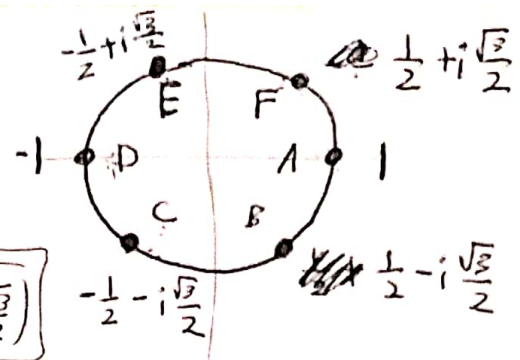
$$A = e^{-i2\pi\left(\frac{0}{6}\right)} = 1$$

$$B = e^{-i2\pi\left(\frac{1}{6}\right)} = \cos\left(\frac{-2\pi}{N}\cdot\frac{1}{6}\right) + i\sin\left(\frac{-2\pi}{N}\cdot\frac{1}{6}\right) = \frac{1}{2} + \left(-i\frac{\sqrt{3}}{2}\right)$$

$$C = e^{-i2\pi\left(\frac{2}{6}\right)} = -\frac{1}{2} + -i\frac{\sqrt{3}}{2}$$

$$D = -1$$

$$E = -\frac{1}{2} + i\frac{\sqrt{3}}{2}$$

$$F = e^{-i2\pi\left(\frac{5}{6}\right)} = \frac{1}{2} + i\frac{\sqrt{3}}{2}$$

(circle diagram with points labeled E, F, D, A, C, B and values $-\frac{1}{2}+i\frac{\sqrt{3}}{2}$, $\frac{1}{2}+i\frac{\sqrt{3}}{2}$, $-1$, $1$, $-\frac{1}{2}-i\frac{\sqrt{3}}{2}$, $\frac{1}{2}-i\frac{\sqrt{3}}{2}$)

10, 40, 20, 90, 5, 30

a)

$$F_0 = \cancel{10A + 40B + 20C + 90D + 5E + 30F} = 10 + 40 + 20 + 90 + 5 + 30$$

$$F_1 = 10A + 40B + 20C + 90D + 5E + 30F$$

$$F_2 = \cancel{10A + 40C + 20E + 90A + 5C + 30F} = 10A + 40C + 20E + 90A + 5C + 30E$$

$$F_3 = 10A + 40D + 20A + 90D + 5A + 30D$$

$$F_4 = 10A + 40E + 20C + 90A + 5E + 30C$$

$$F_5 = 10A + 40F + 20E + 90D + 5C + 30B$$

B) Because frequency is diluted into 2 parts, the positive and the negative part. So, the max. Frequency cannot exceed N/2 (Nyquist Limit).

(Same as above)

c)

$$F_0 = 10 + 40 + 20 + 90 + 5 + 30$$

$$F_1 = 10A + 40B + 20C + 90D + 5E + 30F$$

$$F_2 = 10A + 40C + 20E + 90A + 5C + 30E$$

$$F_3 = 10A + 40D + 20A + 90D + 5A + 30D$$

$$F_{-1} = F_5 = 10A + 40F + 20E + 90D + 5C + 30B$$

$$F_{-2} = F_4 = 10A + 40E + 20C + 90A + 5E + 30C$$

Actual Computation of Fourier Coeff

$$F_0 = (10 + 40 + 20 + 90 + 5 + 30)/6 \;\;\;\;\; \cancel{\text{...}} = 32.5$$

$$F_1 = -9.58 - 3.61\,i$$

$$F_2 = 8.75 + 0.72\,i$$

$$F_3 = -20.83$$

$$F_4 = 8.75 - .72\,i$$

$$F_5 = -9.58 + 3.61\,i$$