

X.

$$x(t) = a_1 p_1(t) + a_2 p_2(t)$$

$\pm A$

$\pm A$

$$x(t) = \begin{cases} A p_1(t) + A p_2(t) \\ A p_1(t) - A p_2(t) \\ -A p_1(t) + A p_2(t) \\ -A p_1(t) - A p_2(t) \end{cases}$$

4 Possible waveforms.

Consider $A p_1(t) + A p_2(t)$

$$= A \cdot \sqrt{\frac{2}{T}} \cos(2\pi f_c t) + A \cdot \sqrt{\frac{2}{T}} \sin(2\pi f_c t)$$

$$= A \cdot \sqrt{\frac{2}{T}} \left\{ \cos(2\pi f_c t) + \sin(2\pi f_c t) \right\}$$

$$= A \cdot \frac{2}{\sqrt{T}} \left\{ \frac{1}{\sqrt{2}} \cos(2\pi f_c t) + \frac{1}{\sqrt{2}} \sin(2\pi f_c t) \right\}$$

$$= A \cdot \frac{2}{\sqrt{T}} \left\{ \cos \frac{\pi}{4} \cos(2\pi f_c t) + \sin\left(\frac{\pi}{4}\right) \sin(2\pi f_c t) \right\}$$

$$= \frac{2A}{\sqrt{T}} \cdot \cos(2\pi f_c t - \pi/4)$$

— waveform 1

$A_{P_1}(t) + A_{P_2}(t)$

$$A_{P_1}(t) - A_{P_2}(t)$$

$$= A \cdot \frac{2}{\sqrt{T}} \left\{ \cos(2\pi f_c t) - \sin(2\pi f_c t) \right\}$$

$$= A \cdot \frac{2}{\sqrt{T}} \cdot \left\{ \cos\left(\frac{\pi}{4}\right) \cos(2\pi f_c t) - \sin\left(\frac{\pi}{4}\right) \sin(2\pi f_c t) \right\}$$

$$\boxed{= A \cdot \frac{2}{\sqrt{T}} \cos\left(2\pi f_c t + \frac{\pi}{4}\right)}$$

↑
waveform 2

Similarly, $-A p_1(t) + A p_2(t)$

$$= A \cdot \frac{2}{\sqrt{T}} \cos\left(2\pi f_c t + \frac{5\pi}{4}\right)$$

$$\begin{aligned}
 & - A p_1(t) - A p_2(t) \\
 & = \frac{2A}{\sqrt{T}} \cos\left(2\pi f_c t + \frac{3\pi}{4}\right)
 \end{aligned}$$

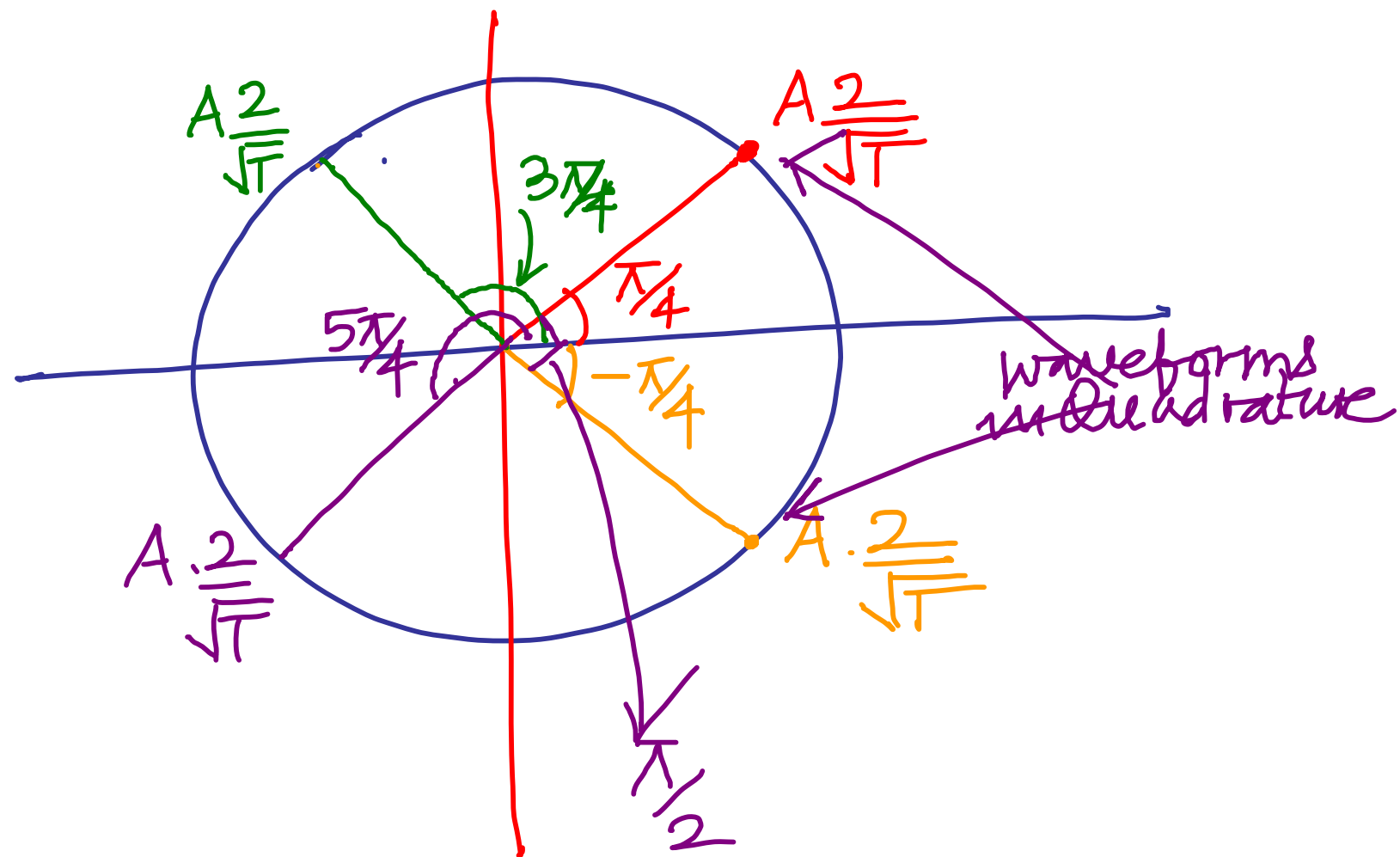
$$x(t) = \left\{ \begin{array}{l} \frac{2A}{\sqrt{T}} \cos\left(2\pi f_c t - \frac{\pi}{4}\right) \\ \frac{2A}{\sqrt{T}} \cos\left(2\pi f_c t + \frac{\pi}{4}\right) \\ \frac{2A}{\sqrt{T}} \cos\left(2\pi f_c t + \frac{3\pi}{4}\right) \\ \frac{2A}{\sqrt{T}} \cos\left(2\pi f_c t + \frac{5\pi}{4}\right) \end{array} \right.$$

Diagram illustrating the sequence of four cosine terms in the sum for $x(t)$. The terms are grouped by a large purple bracket on the right, with arrows pointing to each term and labeled π_2 . An orange line is drawn below the first three terms.

Phase difference between
different waveforms = $\frac{\pi}{2}$
= 90° .

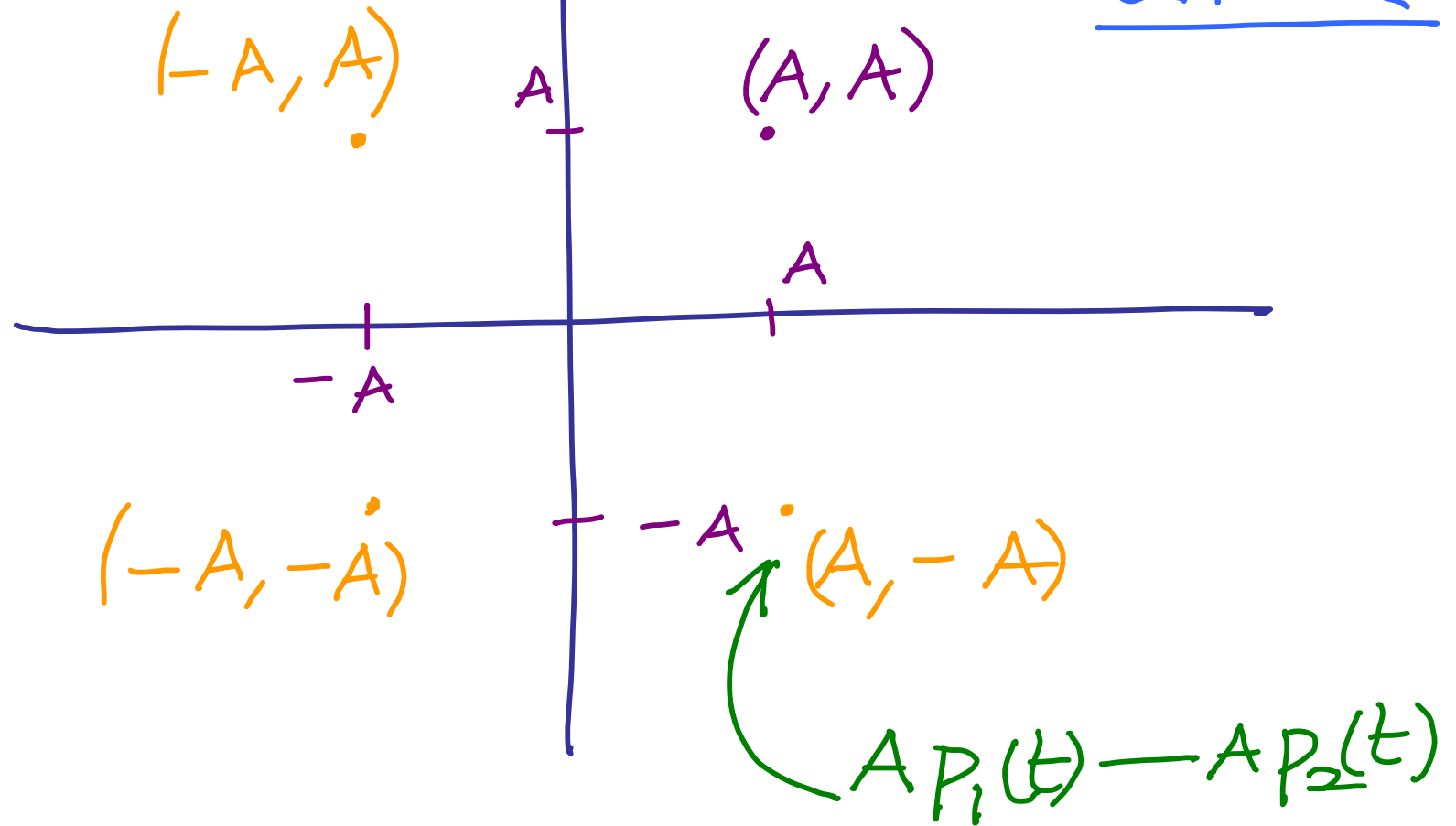
Quadrature

Therefore, the modulation
scheme is termed as Quadrature
Phase Shift Keying (QPSK).



CONSTELLATION DIAGRAM

QPSK.



QPSK

Receiver for QPSK
Matched Filter?