Signal Representation and Passband Communication
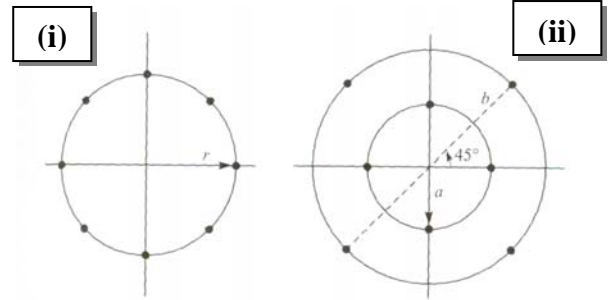
Consider the octal signal point constellations in the figure
Let the basis functions be as follows:

(i)

(ii)

$$\phi_1 = \sqrt{\frac{2}{T}}\cos\left(2\pi f_c t\right) \quad ,0\le t \le T$$

where $\quad f_c = \dfrac{2}{T}$

$$\phi_2 = \sqrt{\frac{2}{T}}\sin\left(2\pi f_c t\right) \quad ,0\le t \le T$$

a) If one of these constellations is used, determine the <u>symbol rate</u> if the desired rate is 90 Mbit/s.

b) What types of modulation are being used for constellation **(i)** and **(ii)** (ASK, PSK, QAM or FSK)? *Justify your answer.*
    <u>constellation **(i)**</u>:
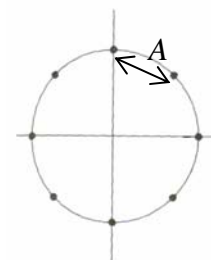
    <u>constellation **(ii)**</u>:

    Consider constellation **(ii)**, is it possible to assign three data bits to each point of the signal constellation such that nearest (adjacent) points differ in only one bit position.
    If possible show your assignment, if not explain why.

c) On the new constellation diagram, draw the decision boundaries.

d) The adjacent signal points in constellation **(i)** are separated by a distance A units.
    Determine the radius r of the circle as function of A.   *Hint : you may use trigonometry*

e) What is the average energy per bit for constellation **(i)** as function of **r.**

f) The nearest-neighbor signal points in constellation **(ii)** are separated by *A* units. **Show** that the radii *a* and *b* of the inner and outer circles are given by

$$a = \frac{A}{\sqrt{2}}, \qquad b = A\left(\frac{1+\sqrt{3}}{2}\right)$$
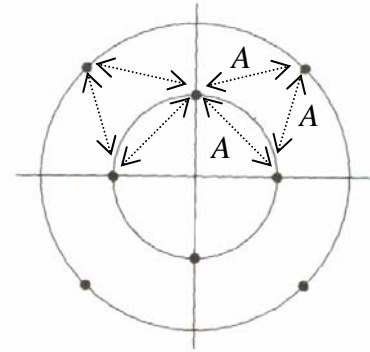
g) Determine the average transmitter powers for the two signal constellations and compare the two powers. What is the relative power advantage of one constellation over the other? (Assume that all points are equally probable). *Compare the two in all aspects.*