Q2: Consider the sentence: *"The kids are playing in the park."* **[4]**

We are given the word embeddings for the word *ball* and *park* as follows:

- Embedding for *ball* = [0.62, 0.32 ,0.48, 0.25]
- Embedding for *park* = [0.78, 0.33, 0.44, 0.63]

Calculate the positional encodings for the word ***park*** in the sentence using the standard sine and cosine formulas. Show your calculations for each dimension of the positional encodings.

1. Determine the Position of "park":

The sentence is: "The kids are playing in the park."

The word "park" is the 7th word in the sentence. Therefore, its position *pos* is 6 (we usually use zero-based indexing).

2. Determine the Embedding Dimension:

The provided word embeddings for "ball" and "park" have 4 dimensions. So, the embedding dimension *d* is 4.

3. Calculate the Positional Encodings:

The standard positional encoding formulas are:

- PE(*pos*, 2*i*) = sin(*pos* / 10000^(2*i*/d))
- PE(*pos*, 2*i* + 1) = cos(*pos* / 10000^(2*i*/d))

where:

- *pos* is the position of the word.
- *i* is the dimension index (0, 1, 2, 3 in this case).
- *d* is the embedding dimension.

Now, we calculate the positional encodings for each dimension:

- **PE(6, 0) = sin(6 / 10000^(0/4)) = sin(6 / 1) = sin(6) ≈ -0.279**
- **PE(6, 1) = cos(6 / 10000^(0/4)) = cos(6 / 1) = cos(6) ≈ 0.960**
- **PE(6, 2) = sin(6 / 10000^(2/4)) = sin(6 / 100) = sin(0.06) ≈ 0.060**
- **PE(6, 3) = cos(6 / 10000^(2/4)) = cos(6 / 100) = cos(0.06) ≈ 0.998**

4. Final Positional Encoding Vector:

The positional encoding vector for "park" is:

PE("park") = [-0.279, 0.960, 0.060, 0.998]