**Problem 1.1**

Cannot be solved analytically

**Problem 1.2**

Prior:

Likelihood:

PDF kernel form:

**Problem 2.1**

Similarities:

* Both models fall under the category of topic models, which aim to discover the underlying topics in a collection of documents
* Both are based on the assumption that each document is a mixture of different topics, and each topic is associated with a probability distribution over words

Differences:

* Multinomial mixture models modes the distribution of words within a document using a multinomial distribution. Each topic is associated with a probability distribution over the entire vocabulary. Mixture of unigrams models assume that the words in a document are generated independently from a multinomial distribution over the vocabulary for each topic. In other words, it treats each word in isolation and does not capture dependencies between adjacent words.
* Multinomial mixture models do not assume independence between words in a document. The multinomial distribution allows for capturing the co-occurrence patterns of words within topics. Mixture of unigrams models assume word independence within a document, meaning the occurrence of one word does not affect the likelihood of another word appearing.
  + This lack of independence makes multinomial mixture models have more parameters (mixture proportions) and be more complex in general.

**Problem 2.2**

**Problem 2.3**