i)

Having calculated the probabilities, we are now able to find the entropy of the encoding. All we need to do is calculate the entropy for each element inside the loop after its probability is determined. So, we will simply define a variable that will compute the entropy for each pair.

```
orizodia_edropia = 0;
```

Outside the loop, we initialize it with an initial value of 0 to get the correct result.

```
orizodia_edropia = orizodia_edropia + pithanotita *
log2(1/pithanotita);
```

Inside the loop, for each iteration, the entropy of the pair is calculated, and each time we add the previous value to the current one to get the total result. We calculate the vertical entropy in the same way. The result is:

```
orizodia edropia: 5.7878 katheti edropia: 5.627
```

So, the total entropy is (5.7878 + 5.627) / 2 = 5.7074.

ii) We will need to find the Huffman tree using the command huffmandict in order to calculate the code length.

```
[orizodia_kodikopoihsh, ~] = huffmandict(keys(orizodia_zeugaria),
orizodies_pithanotites);
```

Next, just as we did for the entropy calculation, we will create a loop that calculates the length for each pair in order to find the total length.

```
oriz_mhkoskodika = 0;
for i = 1:length(keys(orizodia_zeugaria))
    kodikas =
orizodia_kodikopoihsh{find(strcmp(keys(orizodia_zeugaria){i},
orizodia_kodikopoihsh(:,1))), 2};
    mhkos = length(kodikas);
    oriz_mhkoskodika = oriz_mhkoskodika + orizodies_pithanotites(i) *
mhkos;
end
```

e retrieve the code for each pair with the command kodikas=orizodia_kodikopoihsh, find the number of bits in the code using the command mhkos=length(kodikas), and finally calculate the average length using the formula p*l. The result is:

```
meso mhkos oriz: 5.8126 bits
meso mhkos kath: 5.6549 bits
```

So, the average length is (5.8126 + 5.6549) / 2 = 5.73375 bits/pair.

5.73375/2=2.866875 bit/symbol.

iii) As in **Question 1**, we will calculate entropy/code length to find the efficiency η.

```
apodotikothta_oriz = edropia_oriz / meso_mhkos_oriz;
disp(['apodotikothta oriz: ', num2str(apodotikothta_oriz * 100),
'%']);
apodotikothta_kath = edropia_kath / meso_mhkos_kath;
disp(['apodotikothta kath: ', num2str(apodotikothta_kath * 100),
'%']);
```

And we get the result:

```
apodotikothta oriz: 99.5732%
apodotikothta kath: 99.5066%
```

Thus, the total efficiency is (horizontal + vertical) / 2 = 99.5399%.