dft

August 5, 2024

```python
[2]: # from scipy.fft import fft, ifft
     import soundfile as sf
     import numpy as np
     import matplotlib.pyplot as plt
```

```python
[122]: def dft(filename, mode):

           data, fs = sf.read(filename)

           N = len(data)
           n = np.arange(0, N)
           k = np.linspace(1, 20000, num=10000)
           X = np.zeros(len(k))

           for i in range (0, len(k)):

               if mode == "real":
                   base_sinusoid = np.cos(2 * np.pi * k[i] * n / N)
                   title_append = " z realnimi sinusoidami"
               elif mode == "complex":
                   base_sinusoid = np.exp(-2j * np.pi * k[i] * n / N)
                   title_append = " s kompleksnimi sinusoidami"

               dot_product = np.dot(data, base_sinusoid)

               X[i] = np.abs(dot_product)

           energy_sum = 0
           for i in range(0, len(X)):
               energy_sum += X[i] ** 2

           present_frequencies = []
           for i in range(0, len(X)):
               if (((X[i] ** 2) * 100 / energy_sum) >= 1):
                   present_frequencies.append(k[i])

           print("Prisotne so naslednje frekvence: ", present_frequencies)
```

```
    plt.figure(1)

    plt.title("Frekvenčna analiza posnetka " + filename + title_append)
    plt.xlabel("Frekvenca")
    plt.ylabel("Amplituda")

    plt.plot(k, X / N)

    plt.show()
```

[123]:
```
dft("a.wav", "real")
dft("a.wav", "complex")
```

Prisotne so naslednje frekvence: [727.0363036303631, 731.036503650365, 733.036603660366, 735.036703670367, 739.0369036903691, 1459.072907290729, 2177.108810881088, 2179.108910891089, 2187.109310931093, 2189.109410941094, 2191.109510951095, 2193.109610961096]
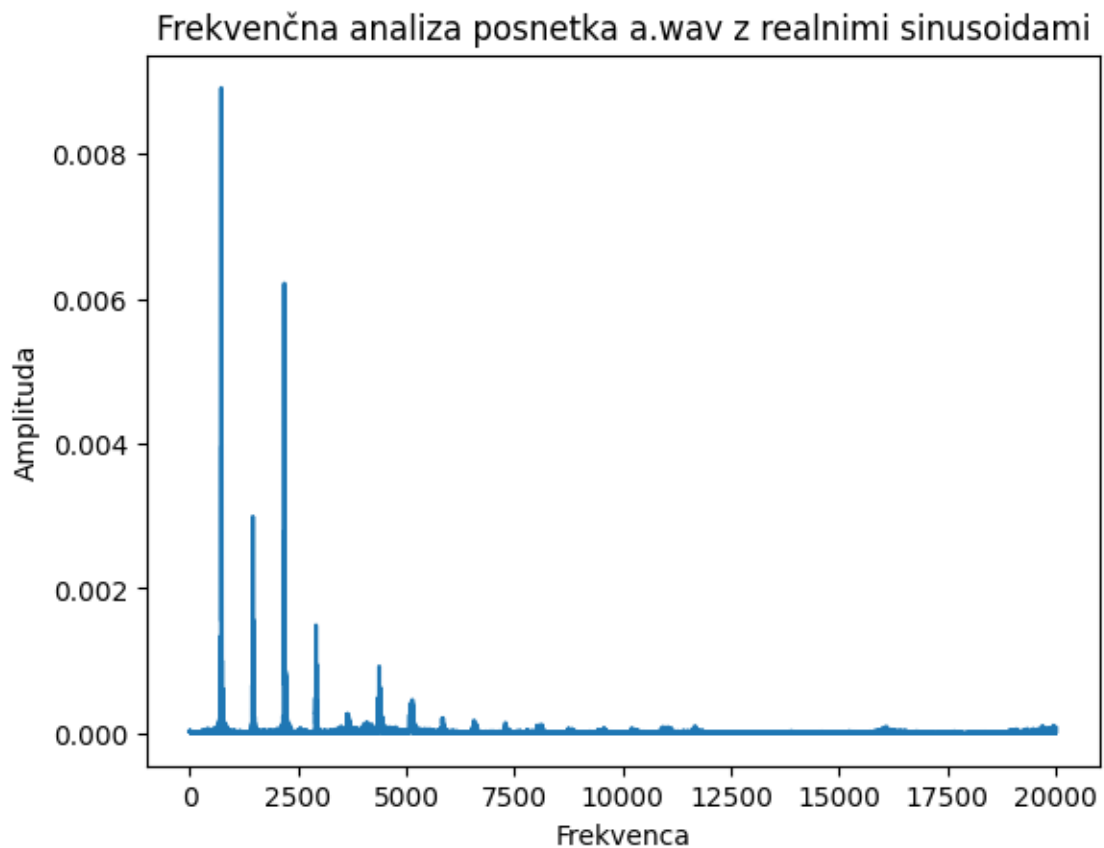
Prisotne so naslednje frekvence: [723.0361036103611, 727.0363036303631, 729.0364036403641, 731.036503650365, 733.036603660366, 735.036703670367,

737.036803680368, 739.0369036903691, 1459.072907290729, 1461.07300730073,
2179.108910891089, 2187.109310931093, 2189.109410941094, 2191.109510951095,
2193.109610961096]

Frekvenčna analiza posnetka a.wav s kompleksnimi sinusoidami
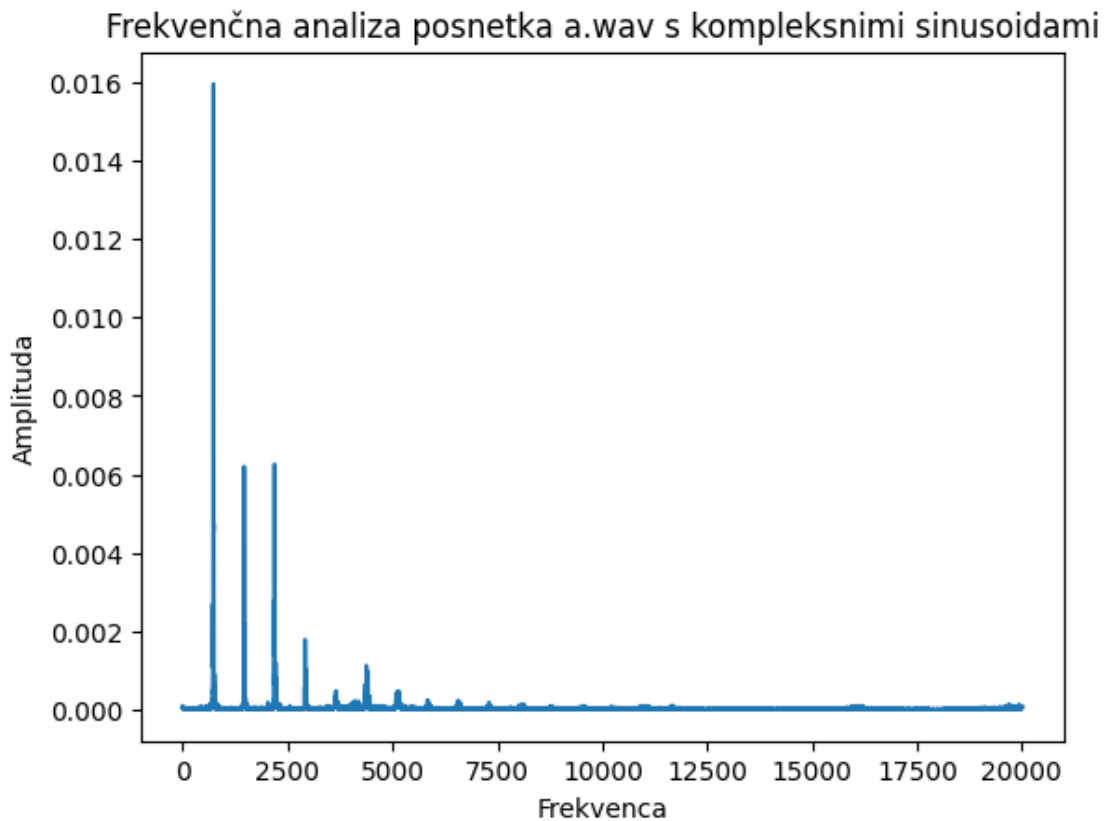

```
[124]: dft("a_high.wav", "real")
       dft("a_high.wav", "complex")
```
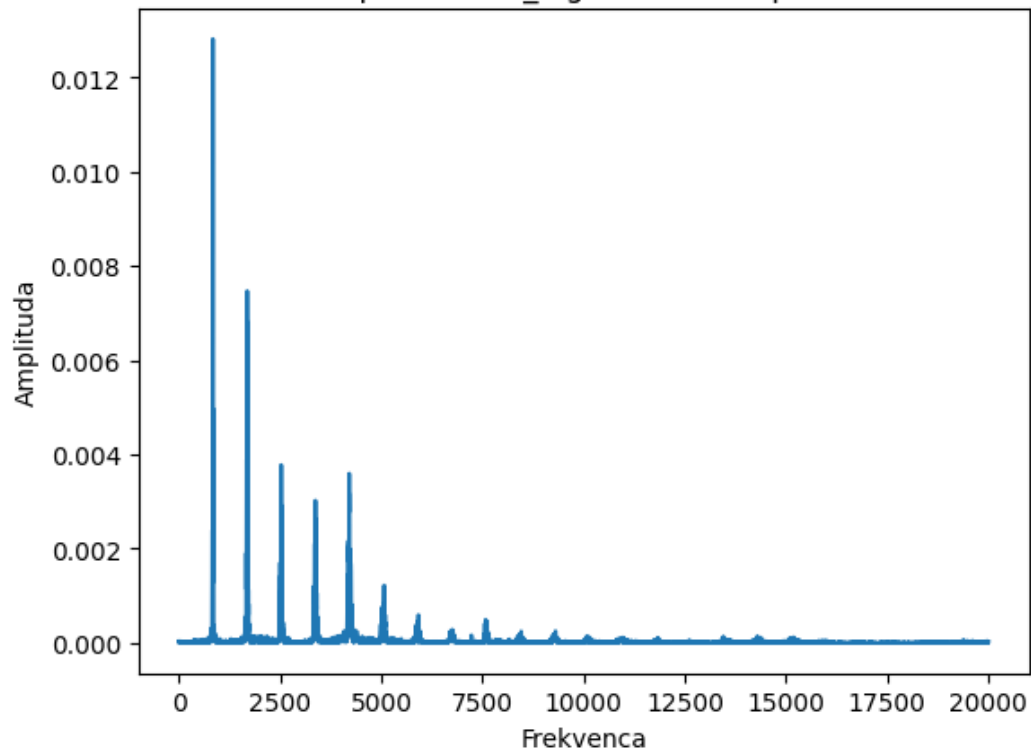
Prisotne so naslednje frekvence: [833.0416041604161, 839.0419041904191,
841.0420042004201, 845.0422042204221, 847.0423042304232, 851.042504250425,
1673.0836083608363, 1681.0840084008403, 1687.0843084308433, 1689.0844084408443,
1691.0845084508453, 1695.084708470847, 1697.084808480848, 2527.1263126312633,
4207.210321032104]

Frekvenčna analiza posnetka a_high.wav z realnimi sinusoidami
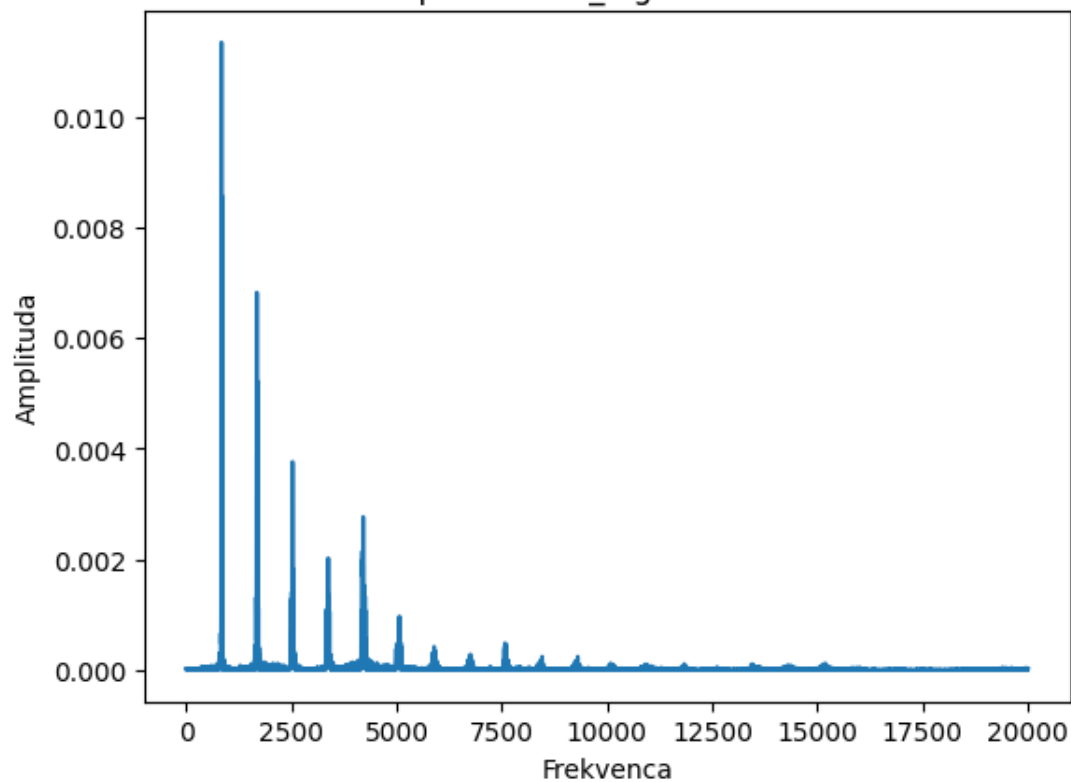
Prisotne so naslednje frekvence: [833.0416041604161, 837.0418041804181, 839.0419041904191, 841.0420042004201, 845.0422042204221, 847.0423042304232, 849.042404240424, 1673.0836083608363, 1677.0838083808383, 1681.0840084008403, 1687.0843084308433, 1691.0845084508453, 1693.0846084608463, 1695.084708470847, 1697.084808480848, 1701.08500850085, 2527.1263126312633, 4209.210421042105]

Frekvenčna analiza posnetka a_high.wav s kompleksnimi sinusoidami

```
[125]: dft("e.wav", "real")
       dft("e.wav", "complex")
```

Prisotne so naslednje frekvence: [767.0383038303831, 1521.0760076007602, 1525.0762076207623, 1529.0764076407643, 1531.0765076507653, 1533.0766076607663, 1535.0767076707673, 1539.076907690769, 1543.077107710771, 2311.115511551155, 6159.307930793079]

Frekvenčna analiza posnetka e.wav z realnimi sinusoidami
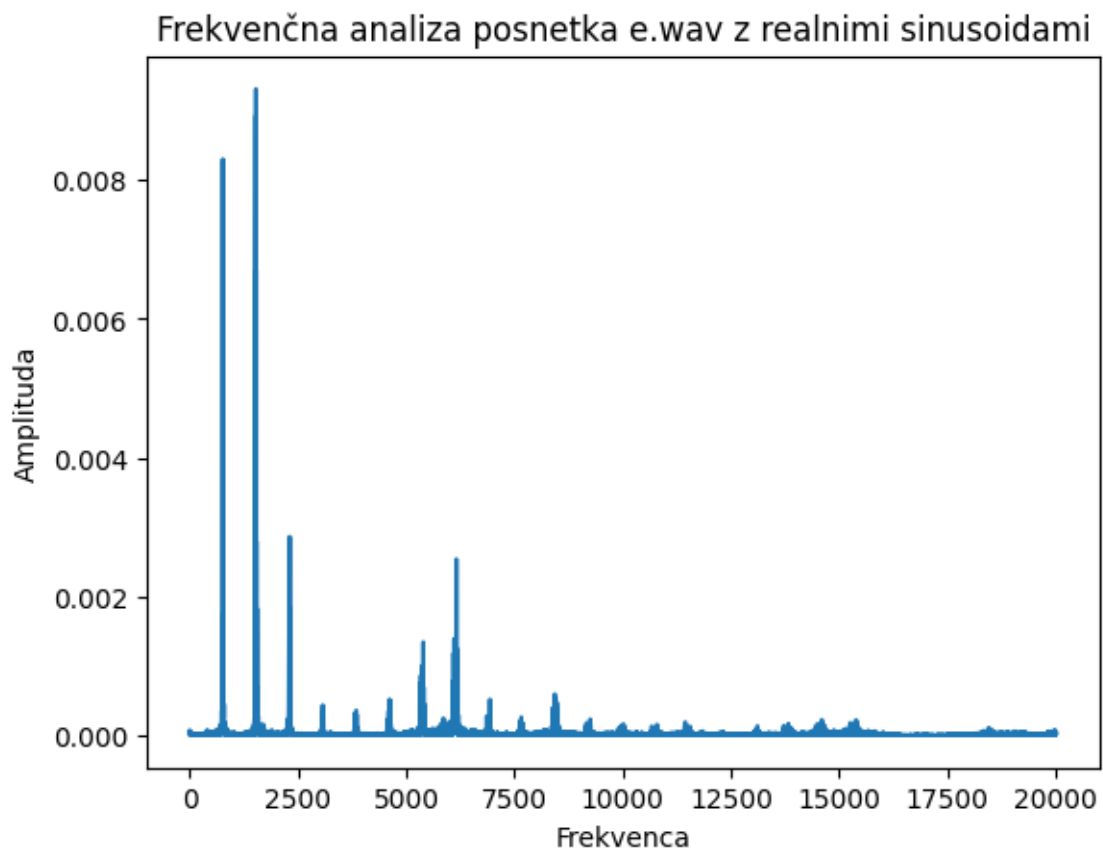
Prisotne so naslednje frekvence: [765.0382038203821, 767.0383038303831, 769.038403840384, 771.038503850385, 775.038703870387, 1525.0762076207623, 1531.0765076507653, 1533.0766076607663, 1535.0767076707673, 1537.076807680768, 1539.076907690769, 1541.07700770077, 1545.077207720772, 1547.077307730773, 2307.115311531153]
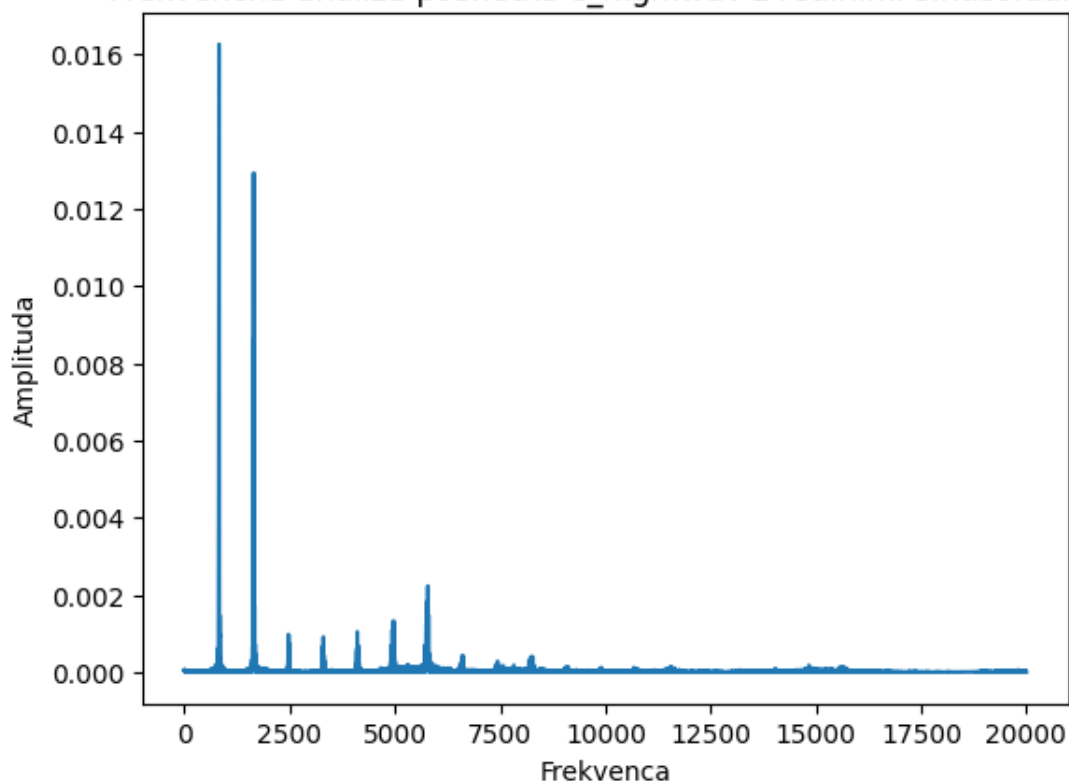
Frekvenčna analiza posnetka e.wav s kompleksnimi sinusoidami
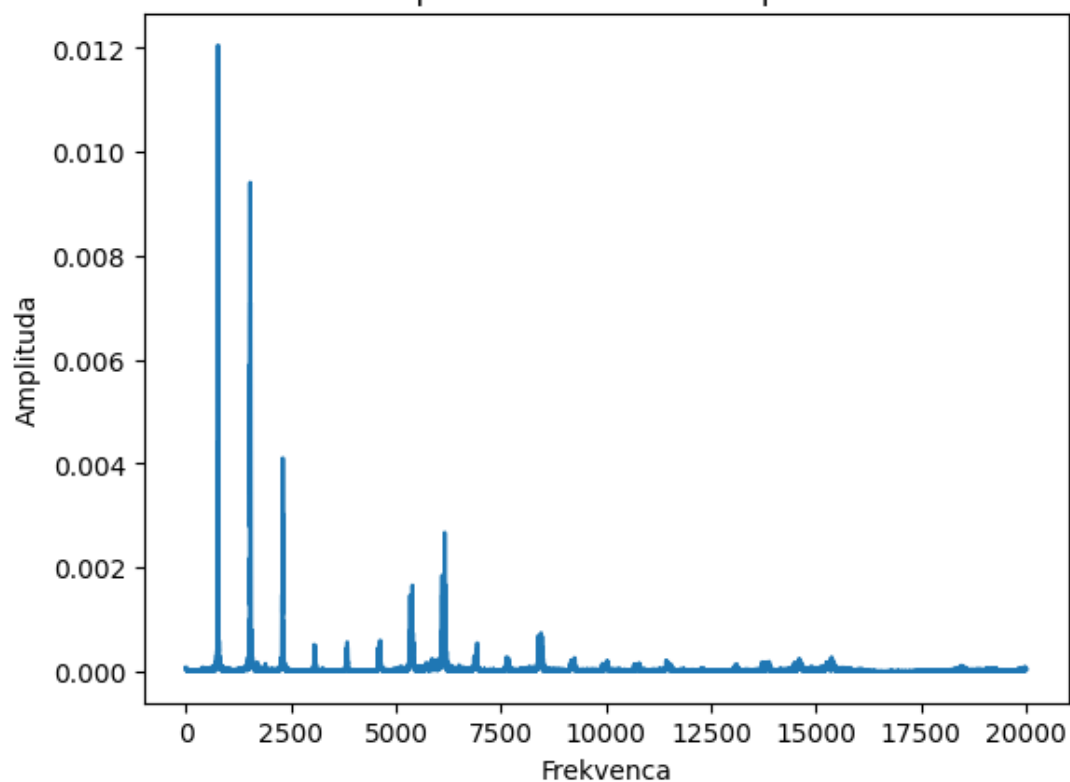

```
[126]: dft("e_high.wav", "real")
       dft("e_high.wav", "complex")
```
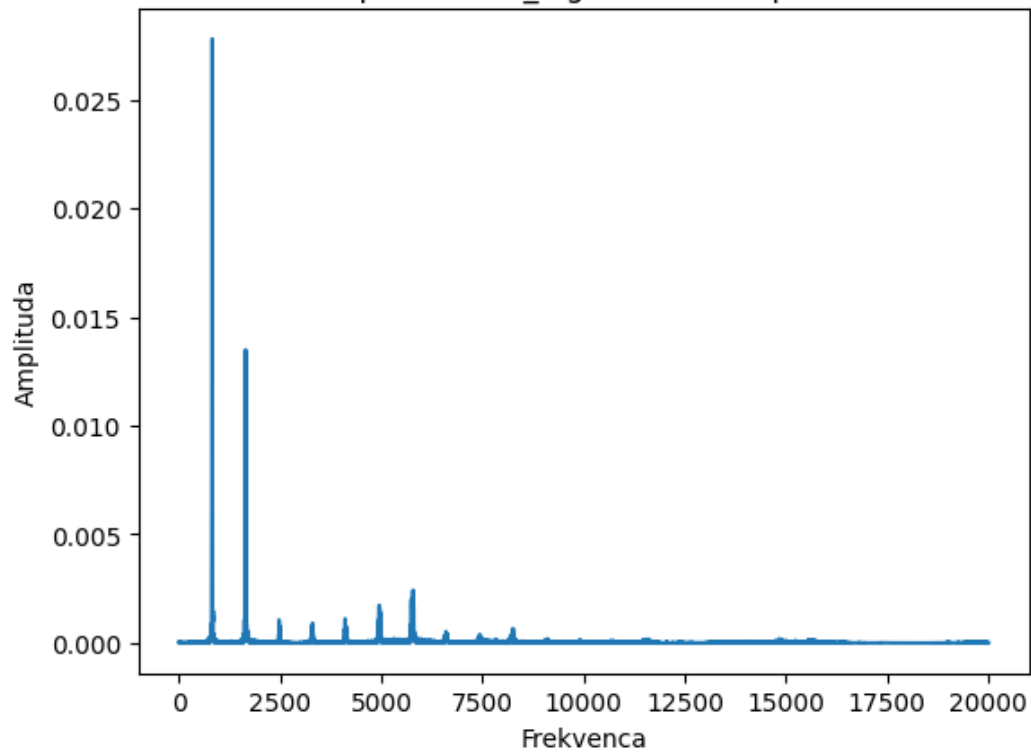
Prisotne so naslednje frekvence: [817.0408040804081, 819.0409040904091,
821.0410041004101, 823.0411041104111, 825.0412041204121, 829.0414041404141,
1639.0819081908191, 1643.0821082108212, 1647.0823082308232, 1649.0824082408242,
1651.0825082508252, 1653.0826082608262, 1659.0829082908292]

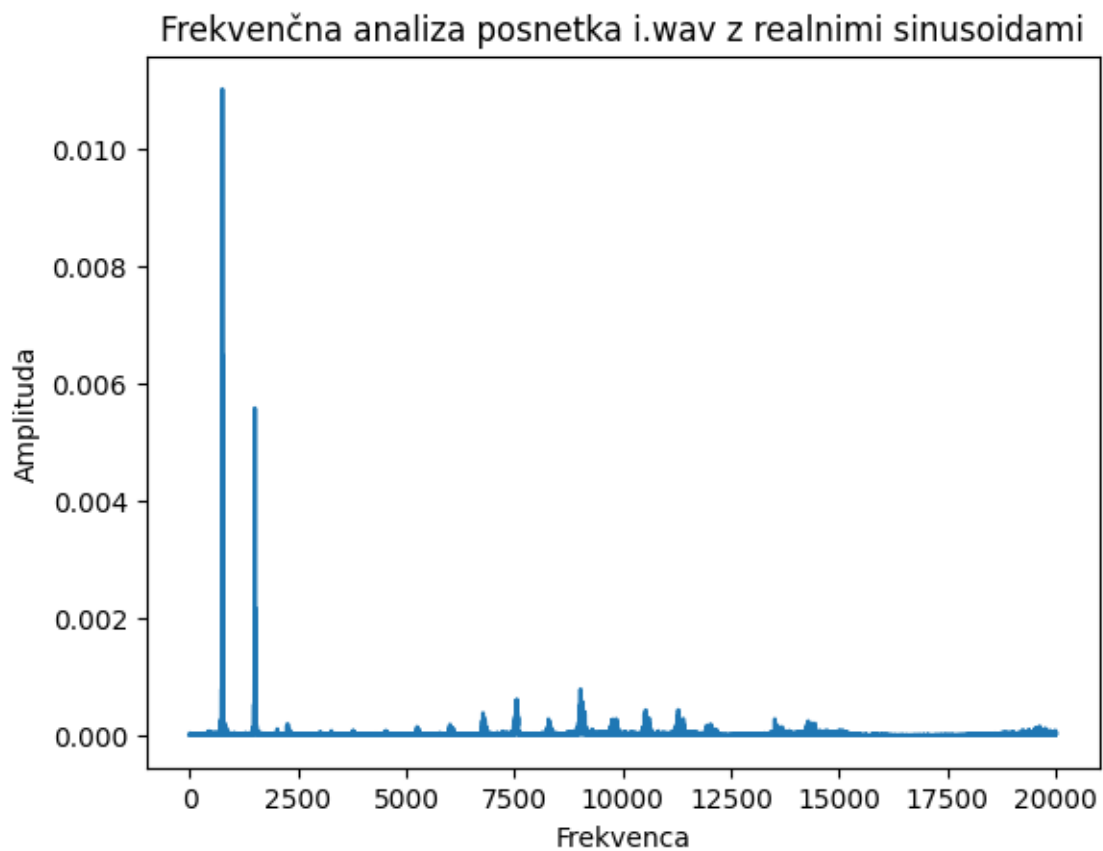Frekvenčna analiza posnetka e_high.wav z realnimi sinusoidami

Prisotne so naslednje frekvence: [817.0408040804081, 819.0409040904091, 821.0410041004101, 823.0411041104111, 825.0412041204121, 827.0413041304131, 829.0414041404141, 1639.0819081908191, 1643.0821082108212, 1649.0824082408242, 1651.0825082508252, 1653.0826082608262, 1655.0827082708272, 1657.0828082808282, 1659.0829082908292, 1661.0830083008302]

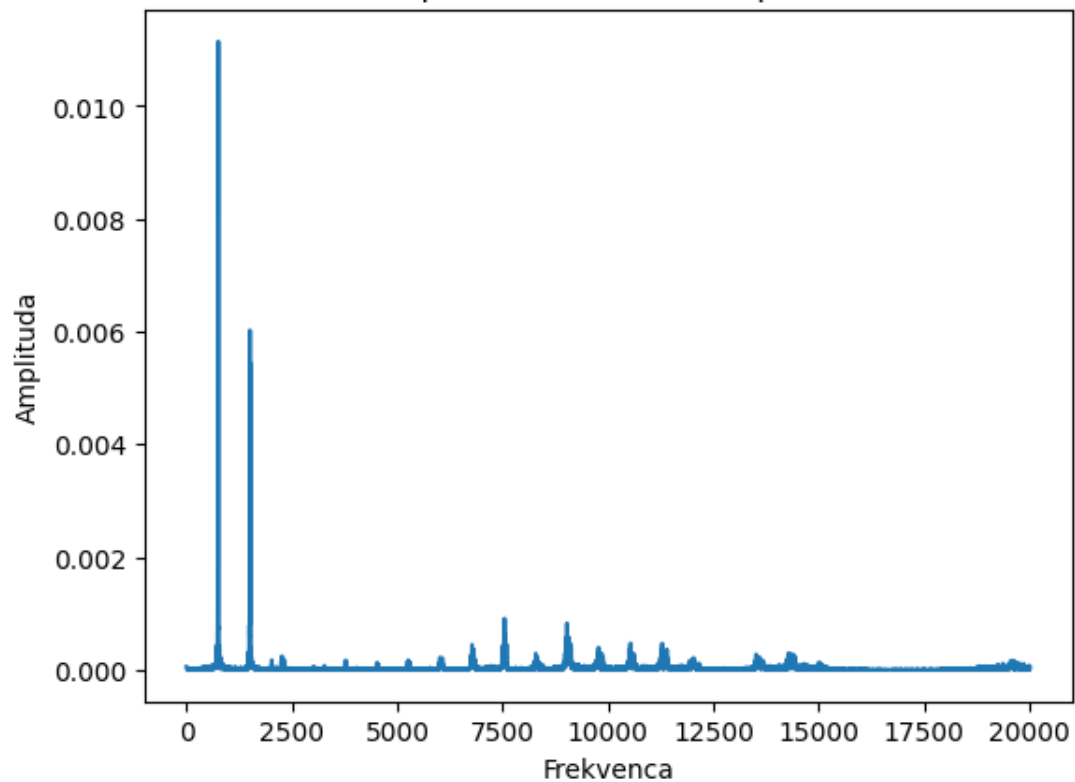## Frekvenčna analiza posnetka e_high.wav s kompleksnimi sinusoidami


```
[127]: dft("i.wav", "real")
       dft("i.wav", "complex")
```

Prisotne so naslednje frekvence: [749.0374037403741, 751.0375037503751,
755.0377037703771, 757.0378037803781, 759.0379037903791, 761.0380038003801,
1503.0751075107512, 1505.0752075207522, 1509.0754075407542, 1515.0757075707572]

Frekvenčna analiza posnetka i.wav z realnimi sinusoidami

Prisotne so naslednje frekvence: [747.0373037303731, 749.0374037403741, 751.0375037503751, 753.0376037603761, 755.0377037703771, 757.0378037803781, 759.0379037903791, 1501.0750075007502, 1503.0751075107512, 1505.0752075207522, 1507.0753075307532, 1511.0755075507552, 1519.0759075907592, 1521.0760076007602]
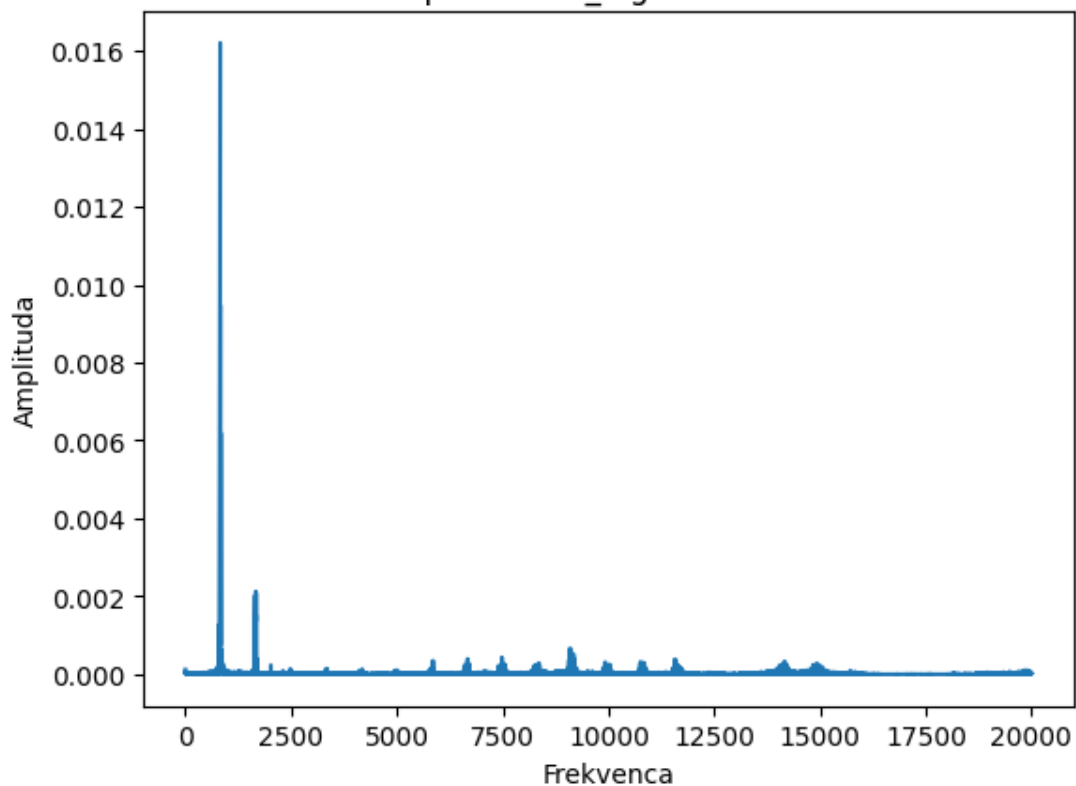
Frekvenčna analiza posnetka i.wav s kompleksnimi sinusoidami

```
[128]: dft("i_high.wav", "real")
       dft("i_high.wav", "complex")
```

Prisotne so naslednje frekvence: [823.0411041104111, 825.0412041204121,
827.0413041304131, 829.0414041404141, 833.0416041604161, 835.0417041704171,
837.0418041804181]

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Frekvenčna analiza posnetka i_high.wav z realnimi sinusoidami

Prisotne so naslednje frekvence: [817.0408040804081, 823.0411041104111, 825.0412041204121, 827.0413041304131, 829.0414041404141, 831.0415041504151, 833.0416041604161, 835.0417041704171, 837.0418041804181]

Frekvenčna analiza posnetka i_high.wav s kompleksnimi sinusoidami
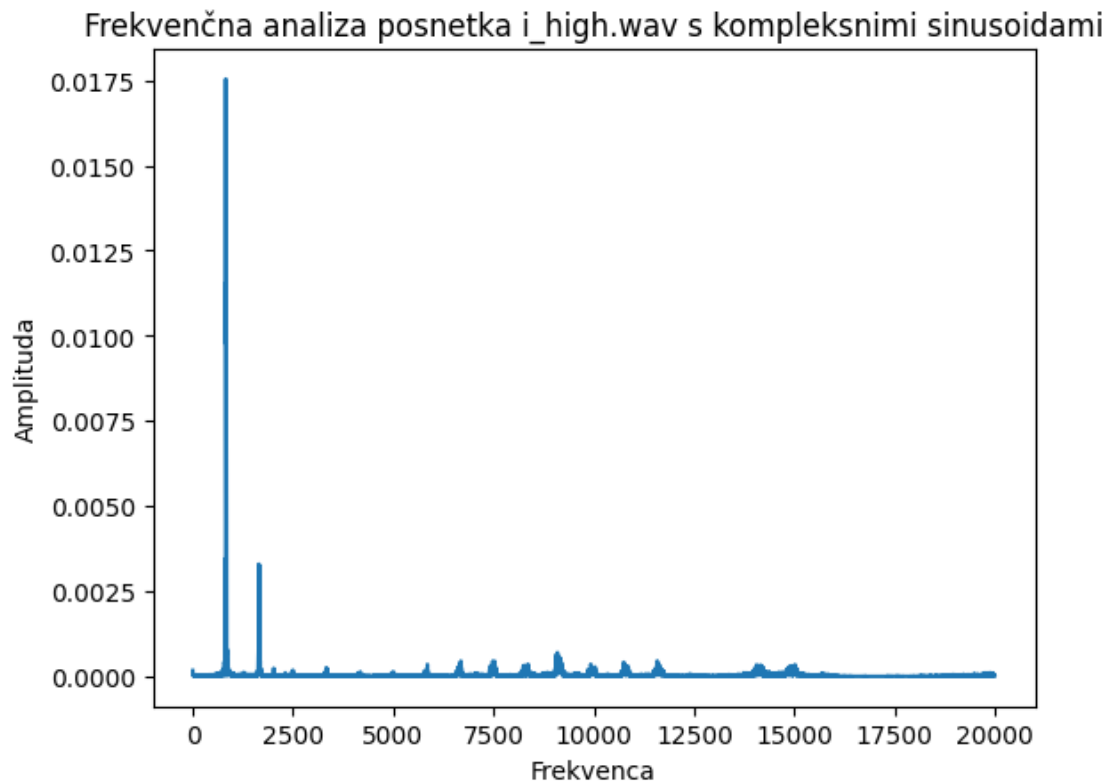


```
[129]: dft("o.wav", "real")
       dft("o.wav", "complex")
```

Prisotne so naslednje frekvence: [755.0377037703771, 757.0378037803781, 761.0380038003801, 1499.0749074907492, 1501.0750075007502, 1509.0754075407542, 1511.0755075507552, 1513.0756075607562, 1515.0757075707572, 1517.0758075807582, 1519.0759075907592, 1521.0760076007602, 1523.0761076107613, 1525.0762076207623]

Frekvenčna analiza posnetka o.wav z realnimi sinusoidami
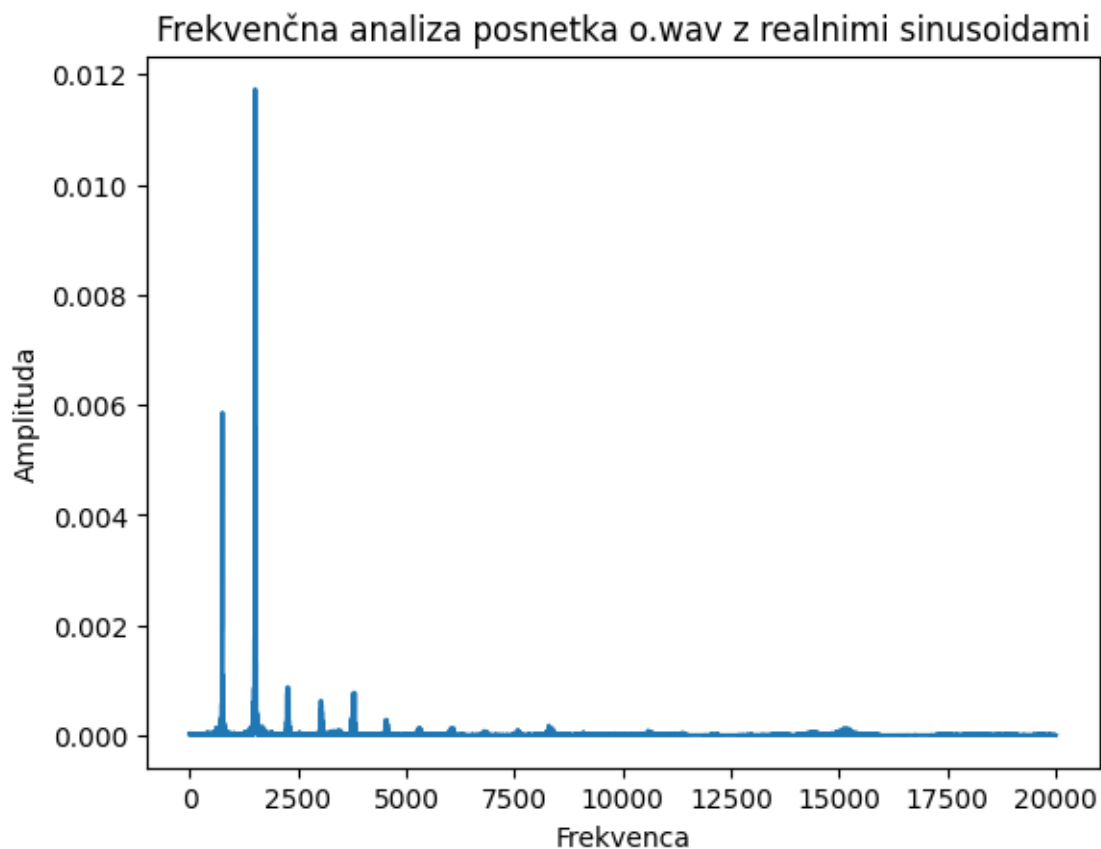
Prisotne so naslednje frekvence: [753.0376037603761, 755.0377037703771,
757.0378037803781, 761.0380038003801, 1499.0749074907492, 1501.0750075007502,
1503.0751075107512, 1507.0753075307532, 1509.0754075407542, 1511.0755075507552,
1513.0756075607562, 1515.0757075707572, 1517.0758075807582, 1519.0759075907592,
1521.0760076007602, 1523.0761076107613, 1525.0762076207623]

## Frekvenčna analiza posnetka o.wav s kompleksnimi sinusoidami
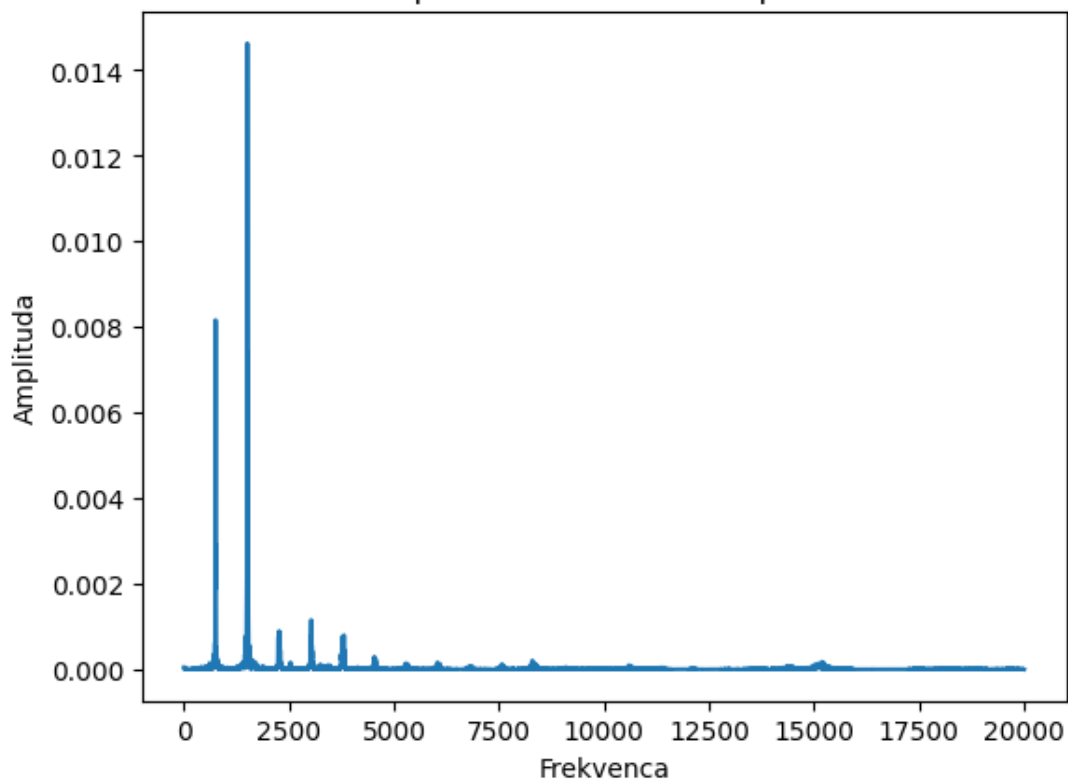

```
[130]: dft("o_high.wav", "real")
       dft("o_high.wav", "complex")
```

Prisotne so naslednje frekvence: [819.0409040904091, 821.0410041004101,
829.0414041404141, 1617.080808080808, 1621.08100810081, 1625.081208120812,
1627.081308130813, 1631.0815081508151, 1633.0816081608161, 1635.0817081708171,
1637.0818081808181, 1639.0819081908191, 1641.0820082008202, 1643.0821082108212,
1645.0822082208222, 3245.162216221622, 3259.1629162916292, 3265.1632163216323]

## Frekvenčna analiza posnetka o_high.wav z realnimi sinusoidami
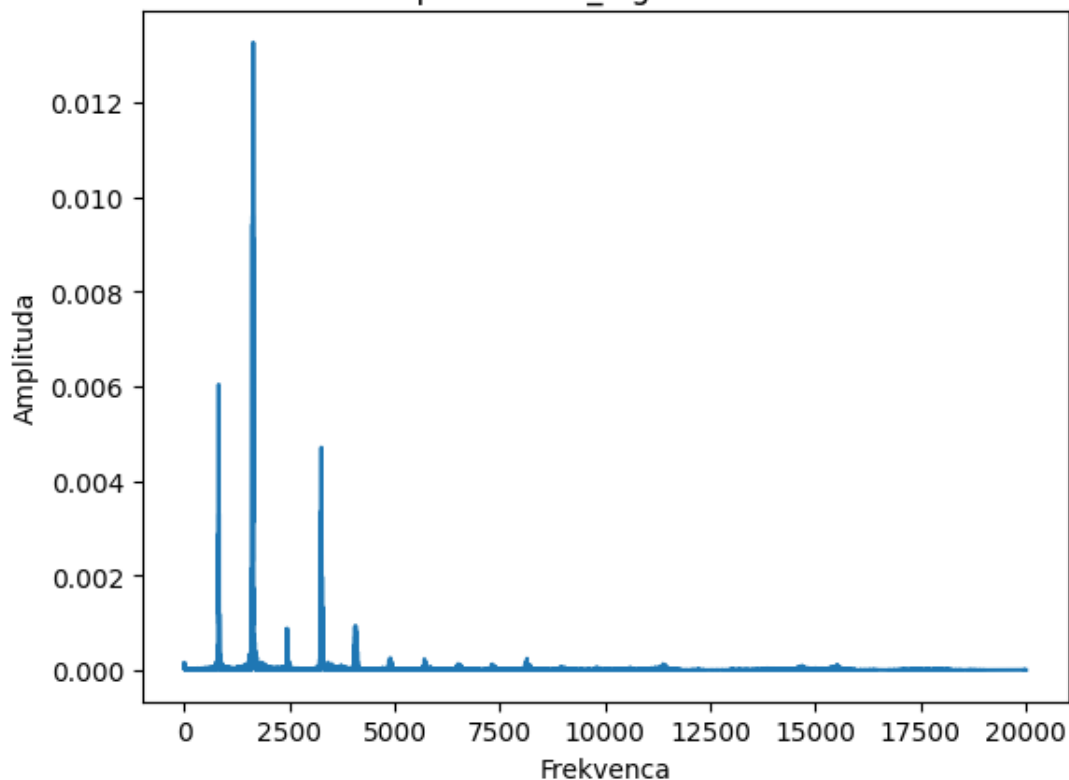
Prisotne so naslednje frekvence: [807.0403040304031, 811.040504050405, 813.040604060406, 815.0407040704071, 819.0409040904091, 821.0410041004101, 1617.080808080808, 1621.08100810081, 1625.081208120812, 1627.081308130813, 1631.0815081508151, 1633.0816081608161, 1635.0817081708171, 1637.0818081808181, 1639.0819081908191, 1641.0820082008202, 1651.0825082508252, 3259.1629162916292]

Frekvenčna analiza posnetka o_high.wav s kompleksnimi sinusoidami
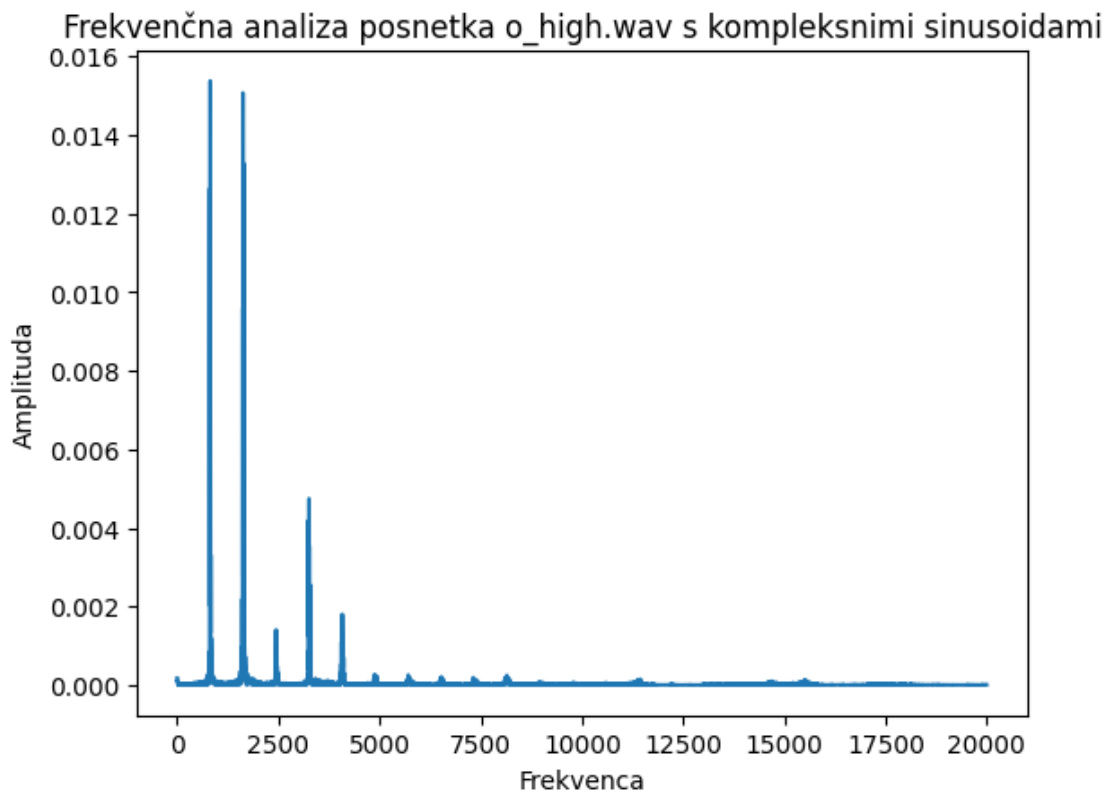


```
[131]: dft("u.wav", "real")
       dft("u.wav", "complex")
```

Prisotne so naslednje frekvence: [643.0321032103211, 645.0322032203221, 647.0323032303231, 665.0332033203321, 669.0334033403341, 675.0337033703371, 681.0340034003401, 1339.0669066906692, 1343.0671067106712, 1349.0674067406742, 1351.0675067506752, 1353.0676067606762, 1355.0677067706772, 1359.0679067906792, 1361.0680068006802, 1363.0681068106812]

Frekvenčna analiza posnetka u.wav z realnimi sinusoidami
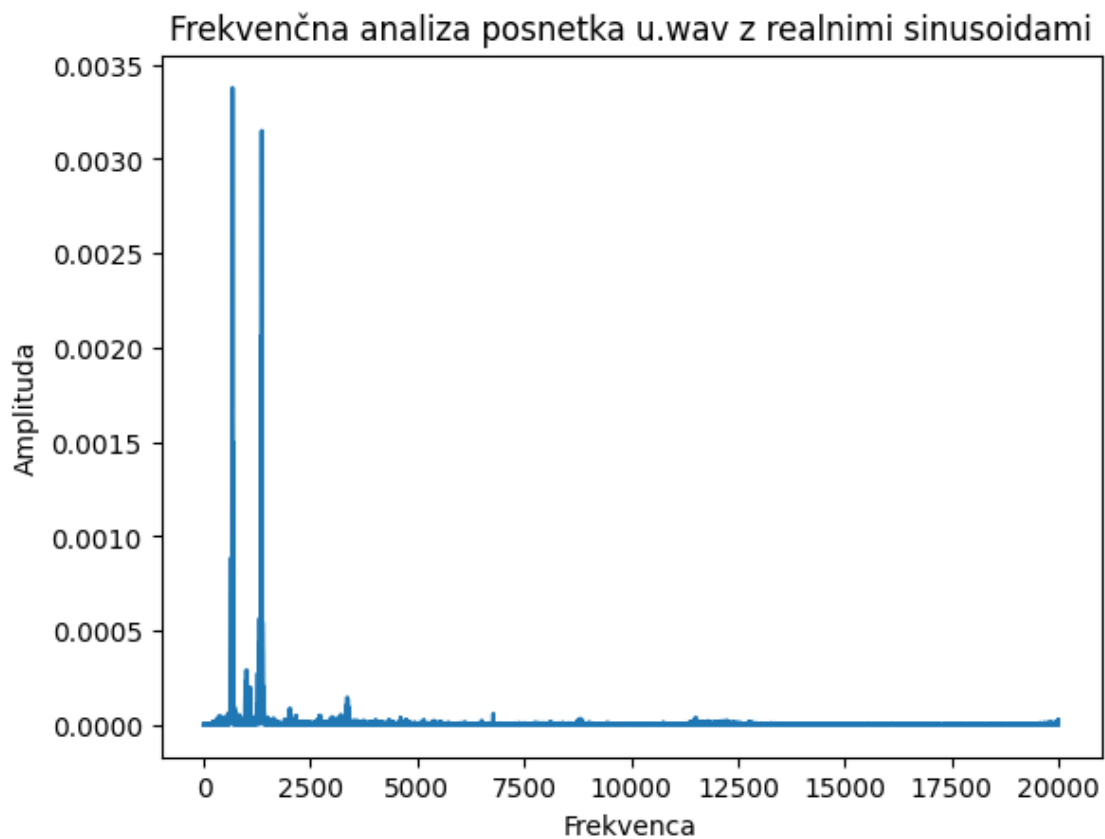
Prisotne so naslednje frekvence: [665.0332033203321, 675.0337033703371, 681.0340034003401, 1339.0669066906692, 1343.0671067106712, 1345.0672067206722, 1347.0673067306732, 1349.0674067406742, 1351.0675067506752, 1353.0676067606762, 1355.0677067706772, 1359.0679067906792, 1361.0680068006802, 1363.0681068106812, 1365.0682068206822]

Frekvenčna analiza posnetka u.wav s kompleksnimi sinusoidami
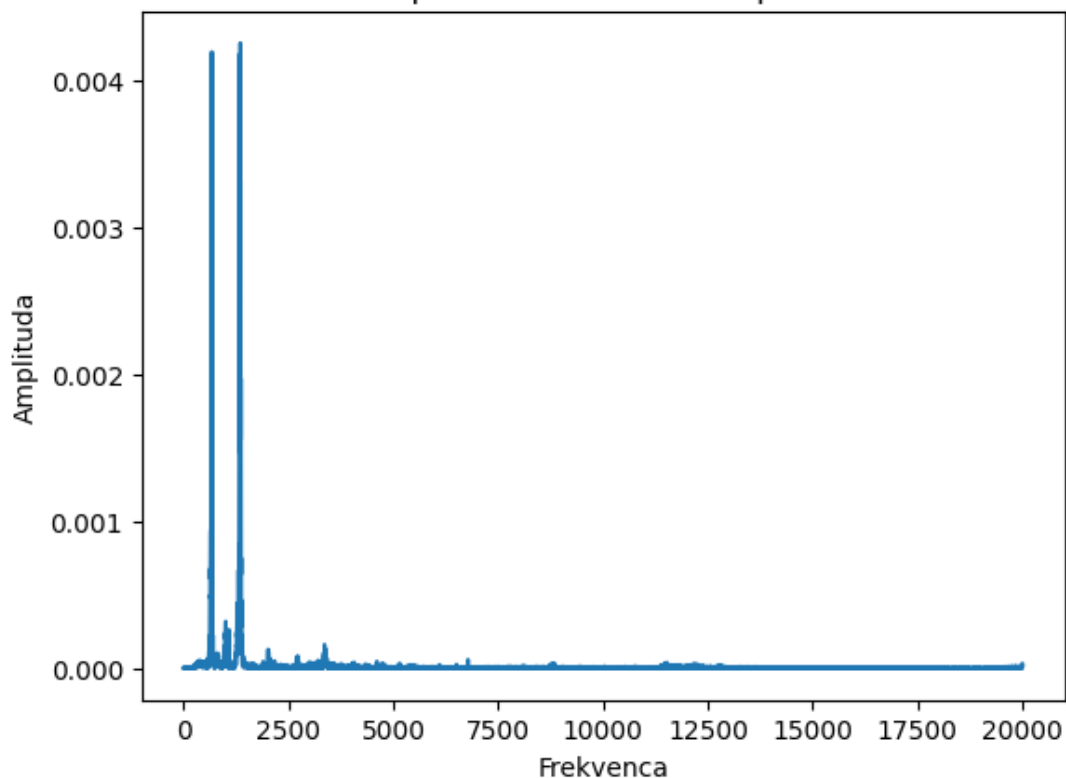
```
[132]: dft("u_high.wav", "real")
       dft("u_high.wav", "complex")
```

Prisotne so naslednje frekvence: [729.0364036403641, 735.036703670367, 737.036803680368, 739.0369036903691, 741.0370037003701, 743.0371037103711, 745.0372037203721, 749.0374037403741, 751.0375037503751, 753.0376037603761, 1463.073107310731, 1471.073507350735, 1475.073707370737, 1477.0738073807381, 1481.0740074007401, 1487.0743074307431]
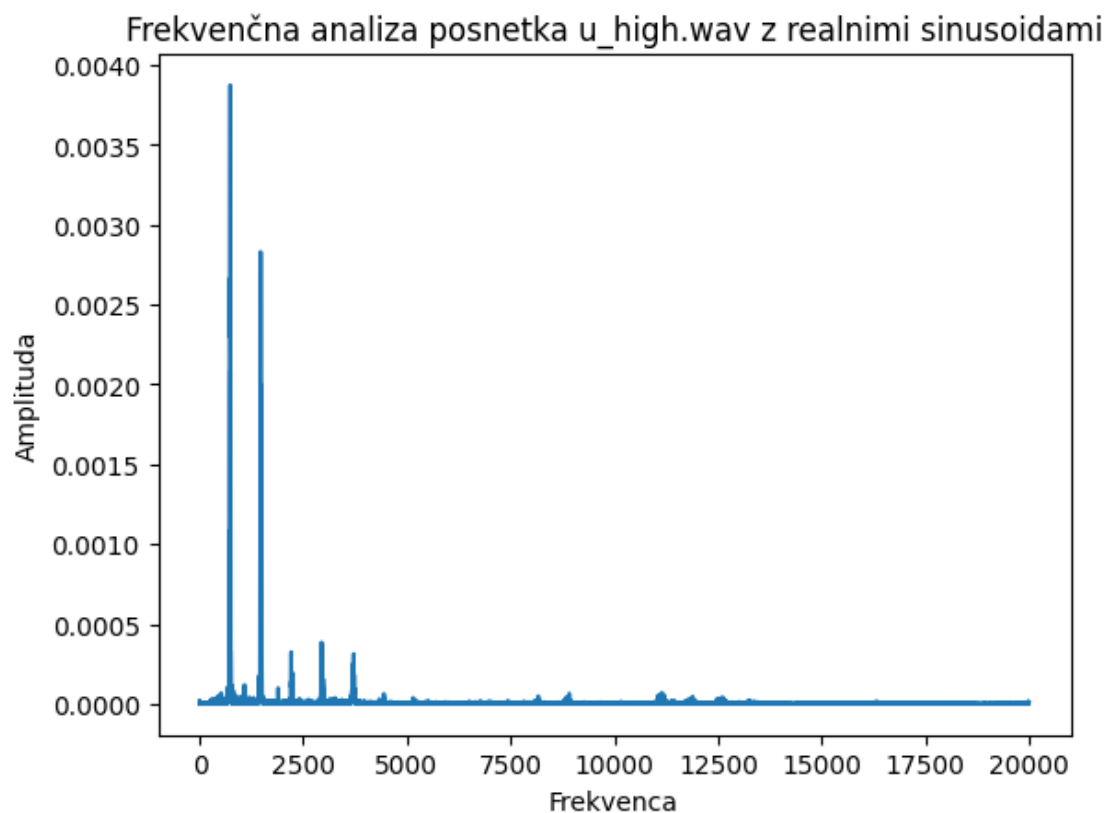
Frekvenčna analiza posnetka u_high.wav z realnimi sinusoidami

Prisotne so naslednje frekvence: [729.0364036403641, 733.036603660366, 735.036703670367, 737.036803680368, 739.0369036903691, 741.0370037003701, 743.0371037103711, 745.0372037203721, 749.0374037403741, 751.0375037503751, 1471.073507350735, 1473.073607360736, 1475.073707370737, 1477.0738073807381, 1481.0740074007401, 1487.0743074307431, 1493.0746074607462]

Frekvenčna analiza posnetka u_high.wav s kompleksnimi sinusoidami
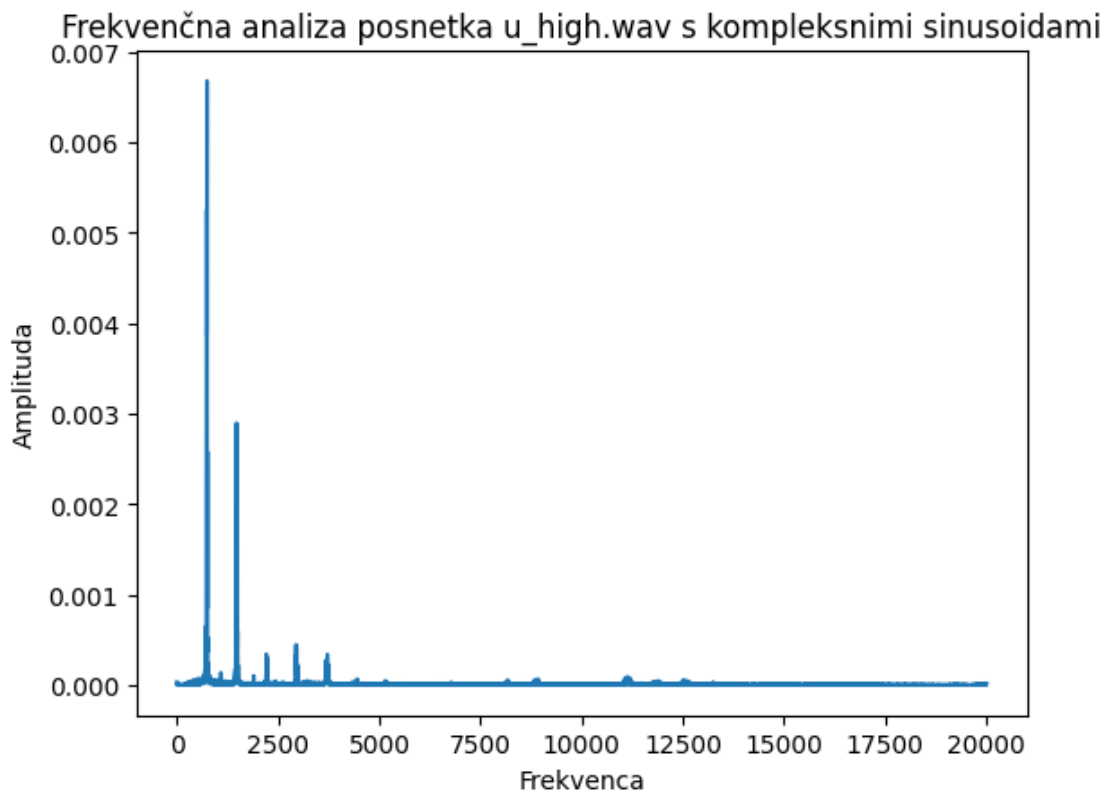


```
[133]:  dft("r.wav", "real")
        dft("r.wav", "complex")
```

Prisotne so naslednje frekvence: [705.0352035203521, 713.0356035603561,
715.0357035703571, 719.0359035903591, 725.0362036203621, 729.0364036403641,
733.036603660366, 743.0371037103711, 747.0373037303731, 749.0374037403741,
751.0375037503751, 755.0377037703771, 805.0402040204021, 809.040404040404,
1463.073107310731, 1495.0747074707472, 1507.0753075307532, 1511.0755075507552,
1513.0756075607562, 1517.0758075807582, 1583.0791079107912, 1609.0804080408043]

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Frekvenčna analiza posnetka r.wav z realnimi sinusoidami
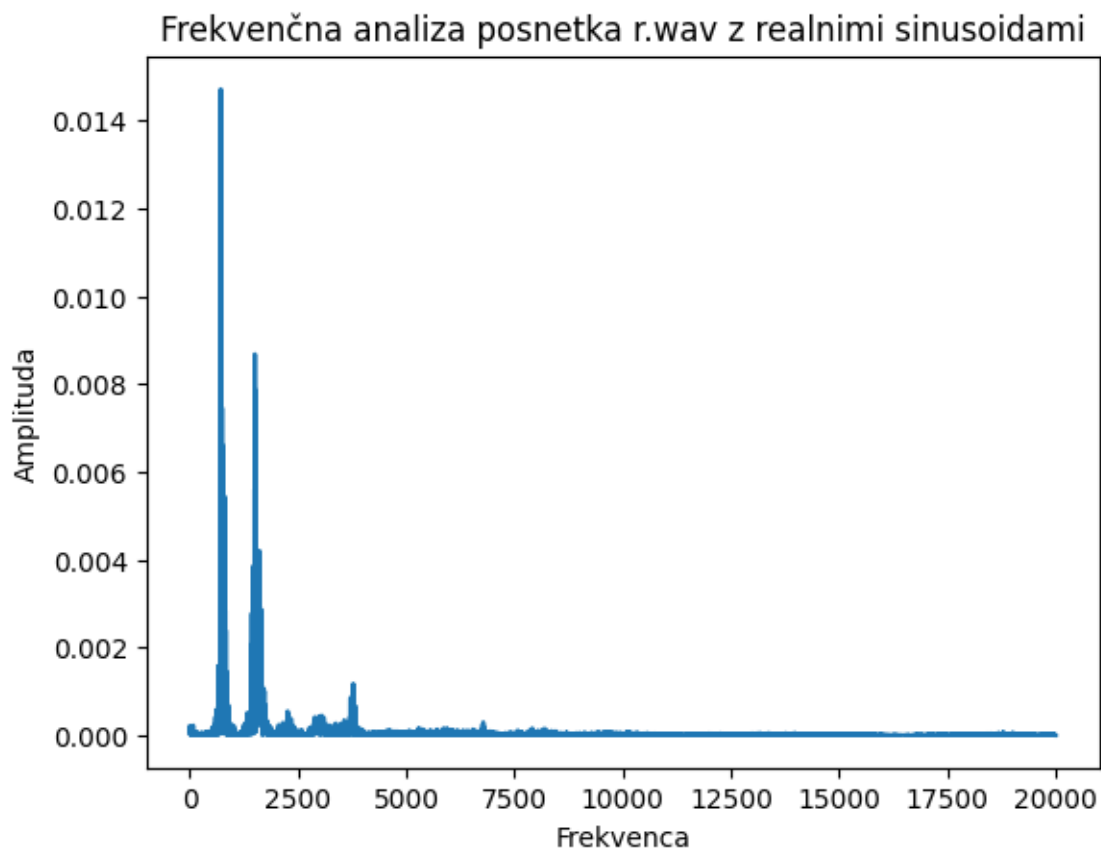
Prisotne so naslednje frekvence: [715.0357035703571, 717.0358035803581,
719.0359035903591, 721.0360036003601, 727.0363036303631, 729.0364036403641,
733.036603660366, 743.0371037103711, 745.0372037203721, 749.0374037403741,
751.0375037503751, 755.0377037703771, 805.0402040204021, 809.040404040404,
823.0411041104111, 1495.0747074707472, 1503.0751075107512, 1507.0753075307532,
1511.0755075507552, 1513.0756075607562, 1517.0758075807582, 1571.0785078507852,
1575.0787078707872]

Frekvenčna analiza posnetka r.wav s kompleksnimi sinusoidami
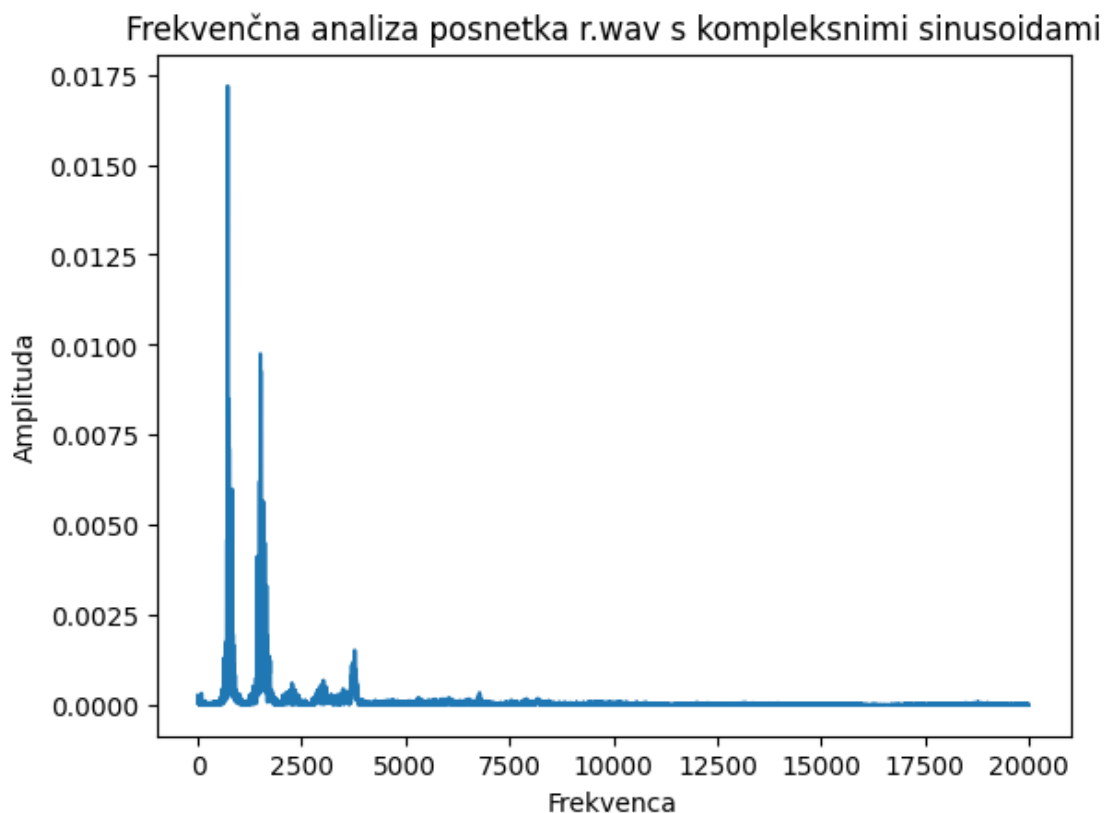
```
dft("r_high.wav", "real")
dft("r_high.wav", "complex")
```
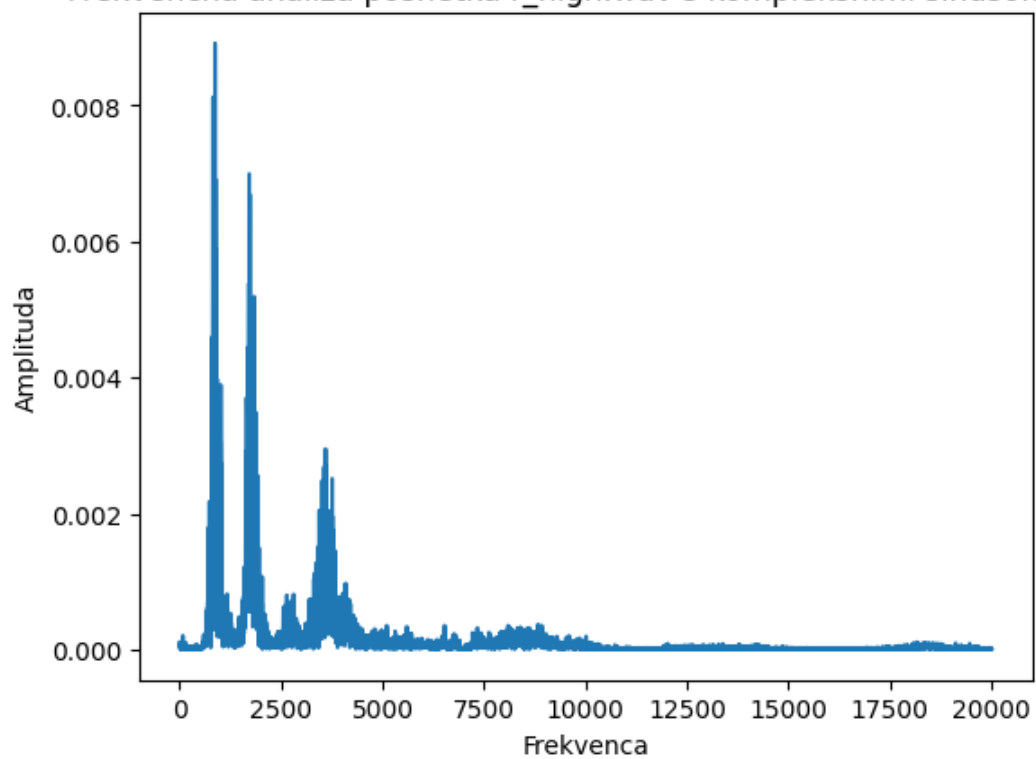
Prisotne so naslednje frekvence: [821.0410041004101, 825.0412041204121, 827.0413041304131, 835.0417041704171, 849.042404240424, 867.0433043304331, 869.0434043404341, 875.0437043704371, 877.0438043804381, 879.0439043904391, 885.0442044204422, 887.0443044304432, 901.0450045004501, 1709.0854085408541, 1711.0855085508551, 1729.0864086408642, 1753.0876087608763, 1757.0878087808783, 1833.0916091609163, 1839.0919091909193]

Frekvenčna analiza posnetka r_high.wav z realnimi sinusoidami
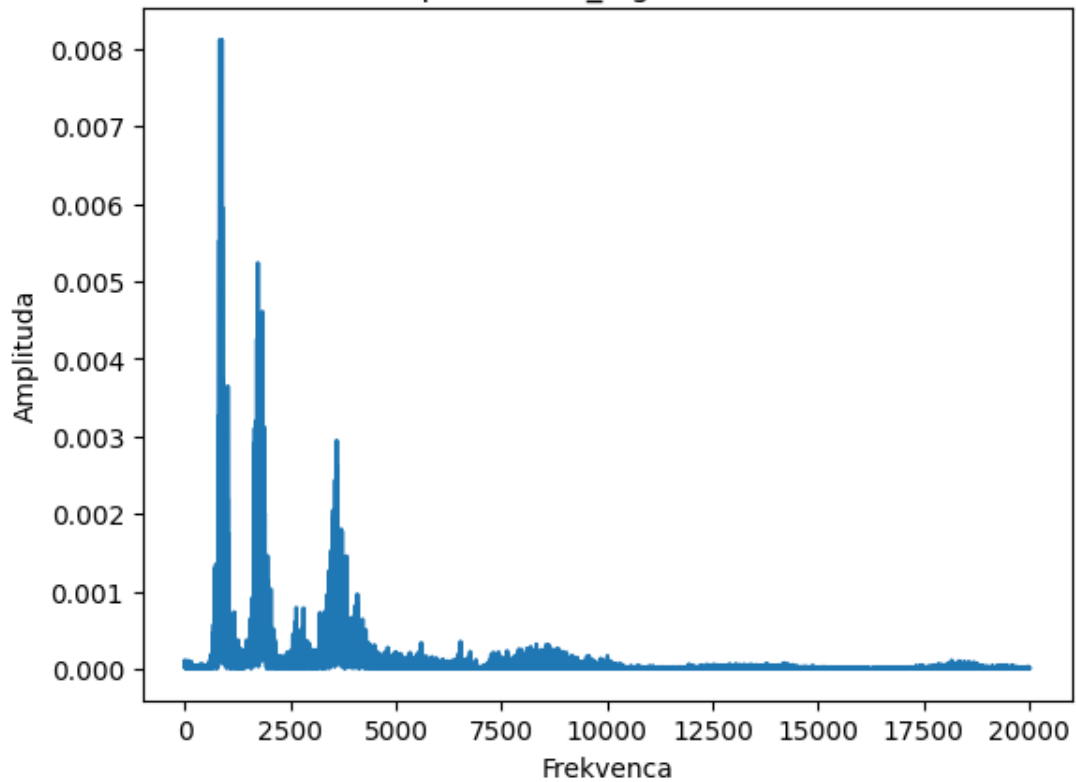
Prisotne so naslednje frekvence: [821.0410041004101, 823.0411041104111, 825.0412041204121, 827.0413041304131, 835.0417041704171, 849.042404240424, 867.0433043304331, 877.0438043804381, 879.0439043904391, 885.0442044204422, 917.0458045804581, 1711.0855085508551, 1717.0858085808582, 1729.0864086408642]
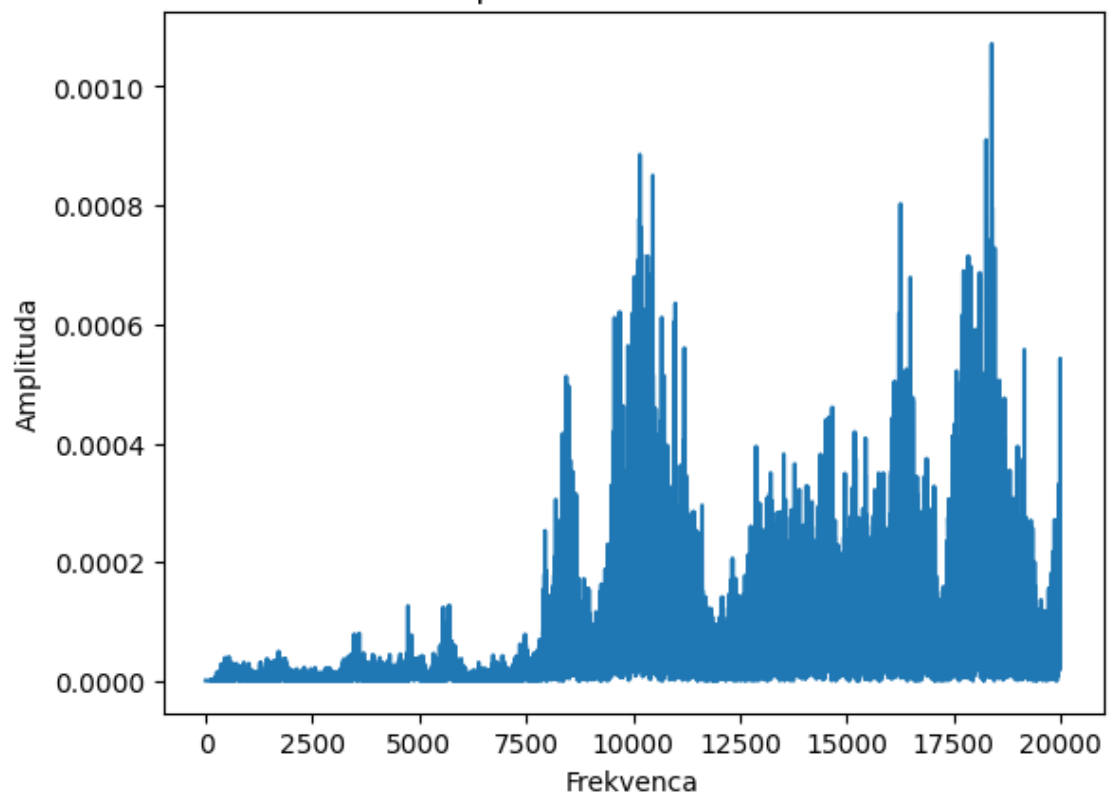
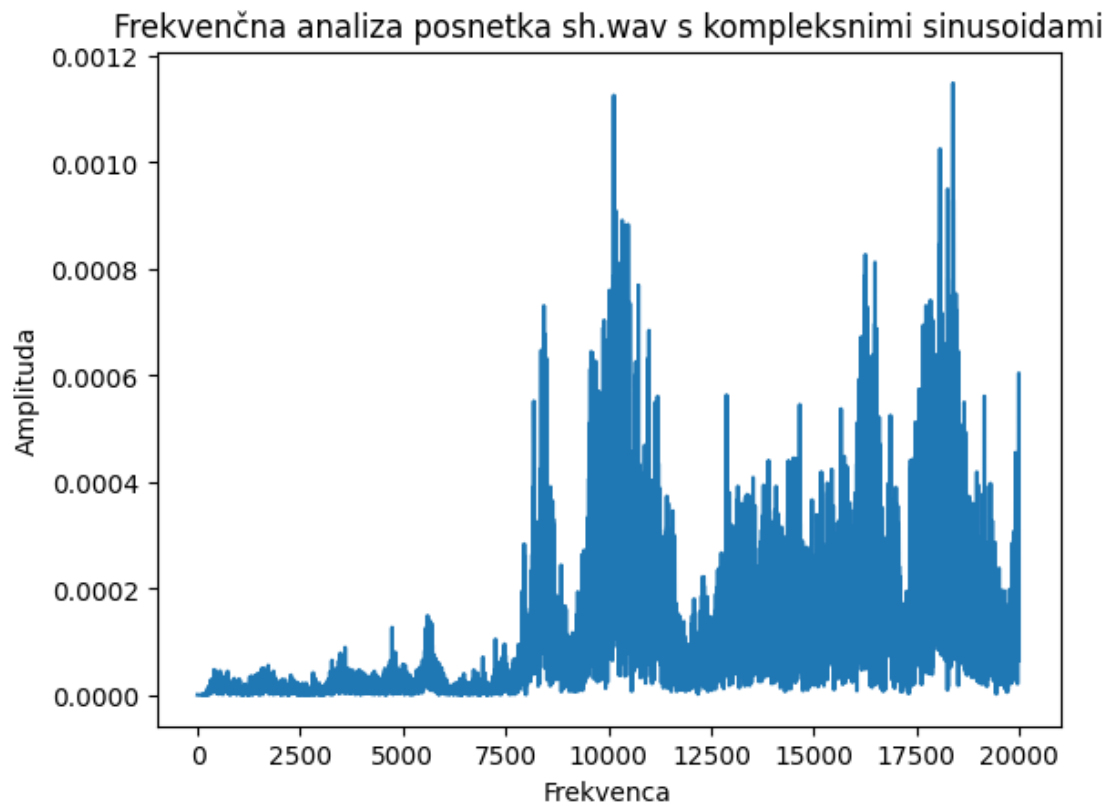Frekvenčna analiza posnetka r_high.wav s kompleksnimi sinusoidami

```
[135]: dft("sh.wav", "real")
       dft("sh.wav", "complex")
```

Prisotne so naslednje frekvence: []

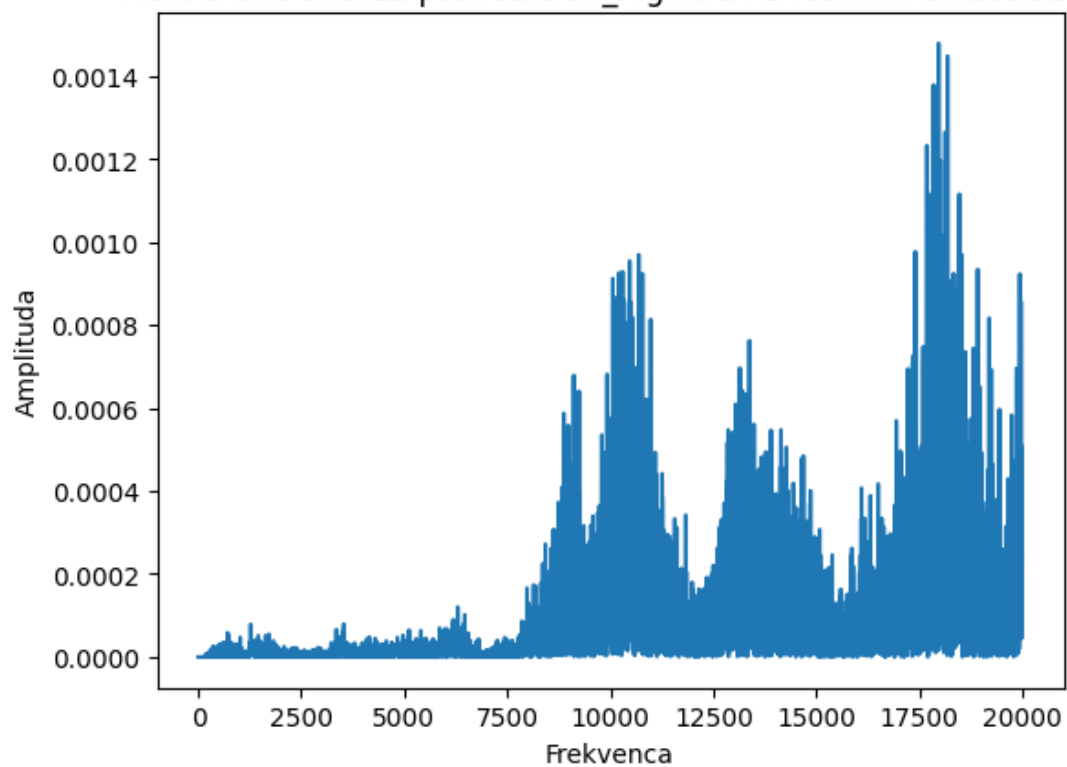Frekvenčna analiza posnetka sh.wav z realnimi sinusoidami

Prisotne so naslednje frekvence: []

Frekvenčna analiza posnetka sh.wav s kompleksnimi sinusoidami

```
[136]:  dft("sh_high.wav", "real")
        dft("sh_high.wav", "complex")
```
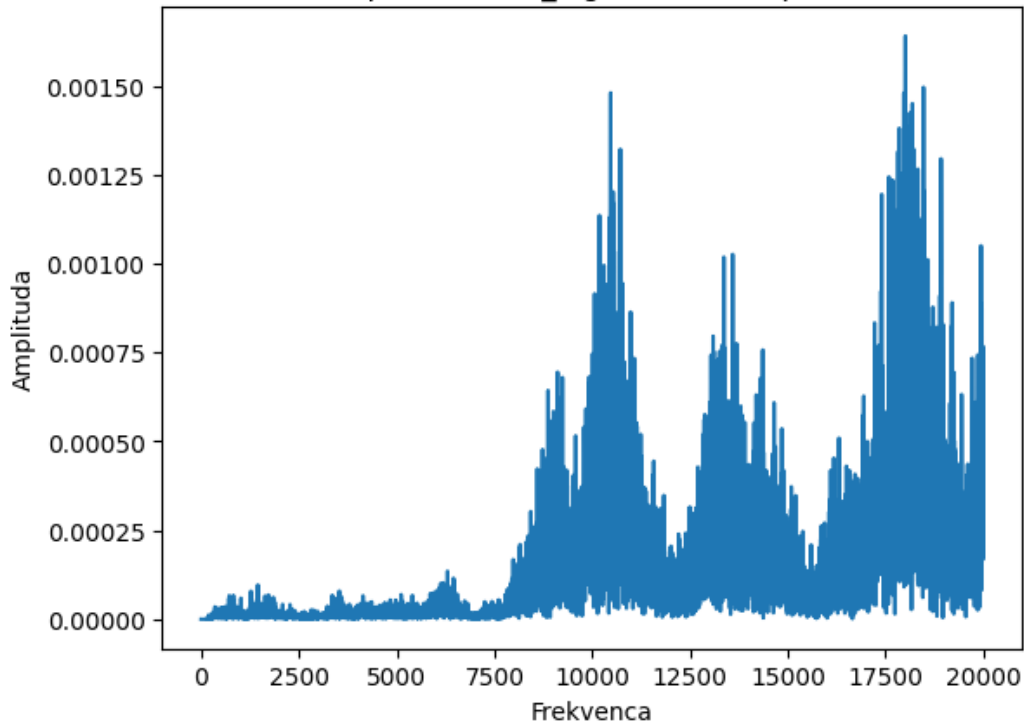
Prisotne so naslednje frekvence: []

Frekvenčna analiza posnetka sh_high.wav z realnimi sinusoidami

Prisotne so naslednje frekvence: []

Frekvenčna analiza posnetka sh_high.wav s kompleksnimi sinusoidami

[ ]:
```
#DFT dekomponira signal na sinusoide, tako kosinusne kot sinusne. Kosinusne␣
↪predstavljajo "realni" del, sinusi pa
#so koeficienti, ki se pomnožijo z i in se imenujejo "imaginarni" del. Za␣
↪različico z realnimi sinusoidami v tem
#programu sem uporabila samo koeficiente kosinusov, zaradi pomanjkanja␣
↪koeficientov sinusov pa ne moremo nedvoumno
#določiti analiziranega signala. Če pa uporabimo tudi sinuse, lahko določimo␣
↪analizirani signal.
#Dolžina opazovanega signala vpliva na frekvenčno ločljivost. Pri daljšem␣
↪opazovanem signalu lahko bolje ločimo
#frekvence, ki so si blizu. Medtem pa krajši signal povzroči spektralno␣
↪puščanje.
#Višji ton signala vodi do višje osnovne frekvence. Ker so harmonike␣
↪večkratniki osnovne frekvence, jih višina
#tona tudi spremeni in jih naredi višje od njihovih ustreznikov z nižjo␣
↪frekvenco (tako bi imela prva harmonika
#z nižjo višino tona nižjo frekvenco kot prva harmonika z višjo višino tona). S␣
↪povečevanjem višine tonov se
#harmonike začnejo oddaljevati druga od druge.
```