Lab_handler

December 12, 2017

1 Обработка лабы

In [1]:
```
import numpy as np
import scipy as sp
import matplotlib.pyplot as plt
from matplotlib.ticker import MultipleLocator
import pandas as pd
from scipy.interpolate import interp1d
```

1.1 RC - цепь

Откроем файл:

In [2]:
```
RC_frame = pd.read_csv('A.csv')
RC_frame.head()
```

Out[2]:

	Unnamed: 0	R	x	x0
0	0	0	-1.2	2.4
1	1	190	-0.8	2.4
2	2	380	-0.9	3.8
3	3	570	-1.3	7.7
4	4	760	-1.1	7.7

При этом $C = 0.5$, а $r = 12.4$

In [3]:
```
RC_R = RC_frame.R
```

In [4]:
```
RC_R_total = RC_R + 12.4
```

Необходимо построить график $\psi = \arctan\left(\dfrac{1}{\Omega C R_\Sigma}\right)$, где $\Omega = 2\pi\nu$, а $\nu = 10^3$

In [5]:
```
RC_X = np.arctan(1/(2*np.pi*10**3 *(0.5*10**(-6)) *RC_R_total))
RC_X.head()
```

Out[5]:
```
0    1.531860
1    1.004427
2    0.681525
3    0.500189
4    0.390898
Name: R, dtype: float64
```

При этом $\psi = -\frac{x}{x_0}\pi$

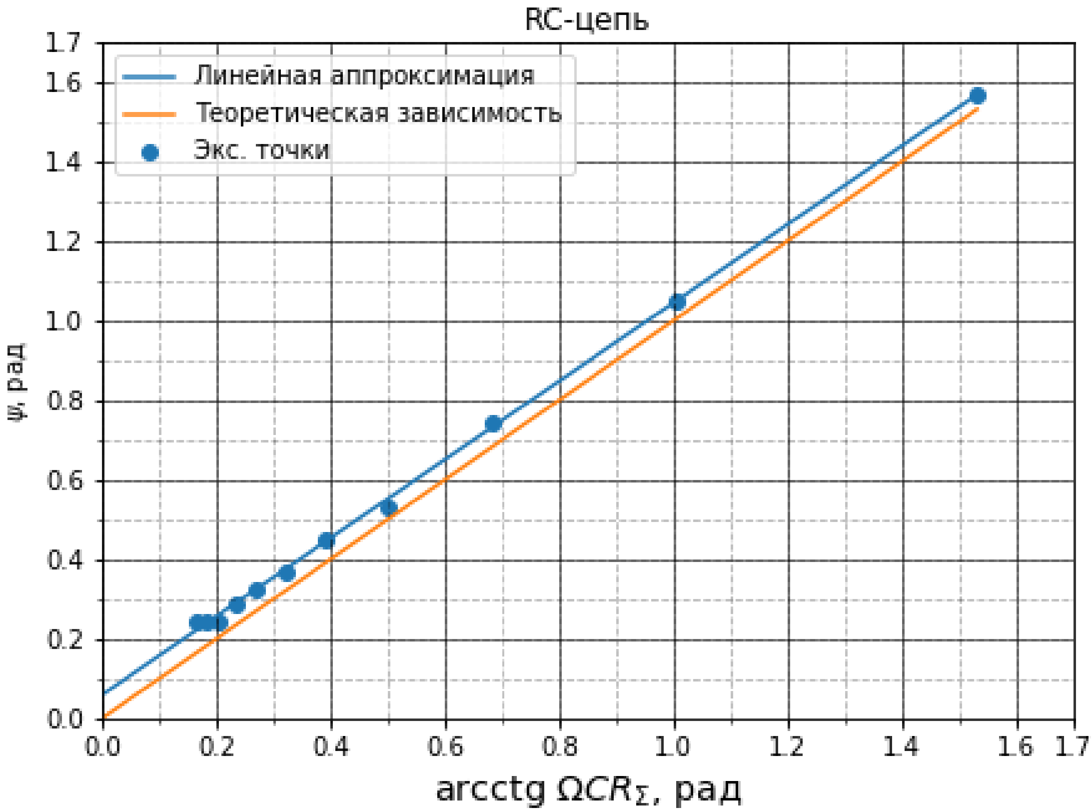
In [6]:
```
RC_Y = -RC_frame.x / RC_frame.x0 * np.pi
RC_Y.head()
```

Out[6]:
```
0    1.570796
1    1.047198
2    0.744061
3    0.530399
4    0.448799
dtype: float64
```

Теперь можно строить график:

In [7]:
```
fig, ax = plt.subplots(figsize=(7, 5))

ax.scatter(RC_X, RC_Y, label='Экс. точки')

RC_coefs = np.polyfit(RC_X, RC_Y, 1)
RC_Y_pred = RC_coefs[0]*RC_X + RC_coefs[1]
RC_X = RC_X.append(pd.Series([0]))
RC_Y_pred = RC_Y_pred.append(pd.Series([RC_coefs[1]]))
ax.plot(RC_X, RC_Y_pred, label='Линейная аппроксимация')

RC_Y_teor = RC_X
ax.plot(RC_X, RC_Y_teor, label='Теоретическая зависимость')

ax.xaxis.set_major_locator(MultipleLocator(0.2))
ax.xaxis.set_minor_locator(MultipleLocator(0.1))
ax.set_xlim((0, 1.7))
ax.yaxis.set_major_locator(MultipleLocator(0.2))
ax.yaxis.set_minor_locator(MultipleLocator(0.1))
ax.set_ylim((0, 1.7))

majc ="#3182bd"
minc ="#deebf7"

# Экстра тики!
plt.xticks(list(plt.xticks()[0]) + [1.7])
plt.yticks(list(plt.yticks()[0]) + [1.7])
ax.set_ylim((0, 1.7))
ax.set_xlim((0, 1.7))

ax.grid(True, 'minor', c='black', alpha=0.3, ls='--')
ax.grid(True, 'major', c='black', alpha=0.6, ls='-')

ax.set_xlabel(r'arcctg $\Omega C R_\Sigma$, рад', size='x-large')
ax.set_ylabel(r'$\psi$, рад')
```

```
ax.set_title(r'RC-цепь')

ax.legend()
plt.savefig('RC.pdf', fmt='pdf')
plt.show(fig)
```



1.2 RL-цепь

Откроем файл:

```
In [8]: RL_frame = pd.read_csv('B.csv')
        RL_frame.head()
```

Out[8]:

	Unnamed: 0	R	x	x0
0	0	0.0	4.0	8.2
1	1	1000.0	3.2	8.4
2	2	2000.0	2.5	8.4
3	3	3000.0	2.0	8.4
4	4	4000.0	1.7	8.4

```
In [9]: RL_R = RL_frame.R
```

Не забудем, что $R_\Sigma = R + r + R_L$, где $R_L = \Omega L = 314$, а $r = 12.4$

In [10]:
```
RL_R_total = RL_R + 12.4 + 314
```

Необходимо построить график $\psi = \arctan\left(\frac{\Omega L}{R_\Sigma}\right)$, где $\Omega = 2\pi\nu$, $\nu = 10^3$, $L = 50$

In [11]:
```
RL_X = np.arctan(2*np.pi*10**3 *50*10**-3 / RC_R_total)
RL_X.head()
```

Out[11]:
```
0    1.531346
1    0.998467
2    0.675113
3    0.494686
4    0.386296
Name: R, dtype: float64
```

При этом $\psi = -\frac{x}{x_0}\pi$

In [12]:
```
RL_Y = -RL_frame.x / RL_frame.x0 * np.pi
RL_Y.head()
```

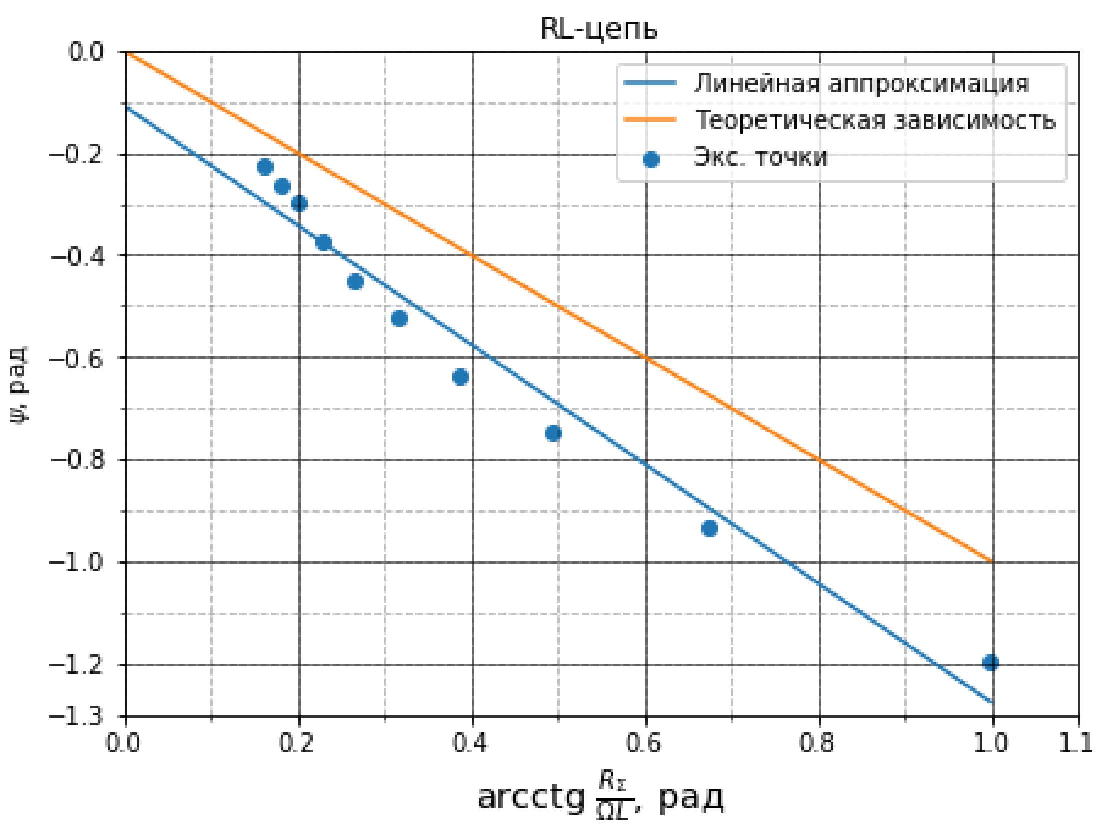
Out[12]:
```
0   -1.532484
1   -1.196797
2   -0.934998
3   -0.747998
4   -0.635799
dtype: float64
```

Теперь можно строить график:

In [13]:
```
# Выбросим первую точку, она плохо аппроксимируется
RL_X = RL_X[1:]
RL_Y = RL_Y[1:]
```

In [14]:
```
fig, ax = plt.subplots(figsize=(7, 5))

ax.scatter(RL_X, RL_Y, label='Экс. точки')

RL_coefs = np.polyfit(RL_X, RL_Y, 1)
RL_X = RL_X.append(pd.Series([0]))
RL_Y_pred = RL_coefs[0]*RL_X + RL_coefs[1]
#RL_Y_pred = RL_Y_pred.append(pd.Series([RL_coefs[1]]))
ax.plot(RL_X, RL_Y_pred, label='Линейная аппроксимация')

RL_Y_teor = - RL_X
ax.plot(RL_X, RL_Y_teor, label='Теоретическая зависимость')
```

```python
ax.xaxis.set_major_locator(MultipleLocator(0.2))
ax.xaxis.set_minor_locator(MultipleLocator(0.1))
ax.set_xlim((0, 1.1))
ax.yaxis.set_major_locator(MultipleLocator(0.2))
ax.yaxis.set_minor_locator(MultipleLocator(0.1))
ax.set_ylim((-1.3, 0))

ax.grid(True, 'minor', c='black', alpha=0.3, ls='--')
ax.grid(True, 'major', c='black', alpha=0.6, ls='-')

# Экстра тики!
plt.xticks(list(plt.xticks()[0]) + [1.1])
plt.yticks(list(plt.yticks()[0]) + [-1.3])
ax.set_ylim((-1.3, 0))
ax.set_xlim((0, 1.1))

ax.set_xlabel(r'arcctg $ \frac{R_\Sigma}{\Omega L}$, рад', size='x-large')
ax.set_ylabel(r'$\psi$, рад')
ax.set_title(r'RL-цепь')

ax.legend()
plt.savefig('RL.pdf', fmt='pdf')
plt.show(fig)
```



1.3 Исследование резонансной кривой

Откроем файл:

```
In [15]: RLC_frame_0 = pd.read_csv('C_0.csv')
         RLC_frame_100 = pd.read_csv('C_100.csv')
```

```
In [16]: RLC_0_v = RLC_frame_0.v
         RLC_100_v = RLC_frame_100.v
```

Учтем, что по теории резонансная частота наступает на $\nu = 1006.6$.
При этом $C = 0.05$, $L = 500$, $R_L = 332$

Тогда теоретическая добротность будет: $Q = \dfrac{1}{R_\Sigma}\sqrt{\dfrac{L}{C}}$

Для $R = 0 \;\Rightarrow\; \boxed{Q = 9.5}$

Для $R = 100 \;\Rightarrow\; \boxed{Q = 7}$

Построим графики $|\psi| = f(\nu/\nu_0)$ и поищем через него добротность по формуле $Q = \nu_0/(2\Delta\nu)$, где $2\Delta\nu/\nu_0$ --- ширина графика при $\psi = \pi/4$

```
In [17]: %%latex
         При этом $\psi = - \cfrac{x}{x_0} \pi$. Но мы будем откладывать $\cfrac{\psi}{\pi} = -\
```

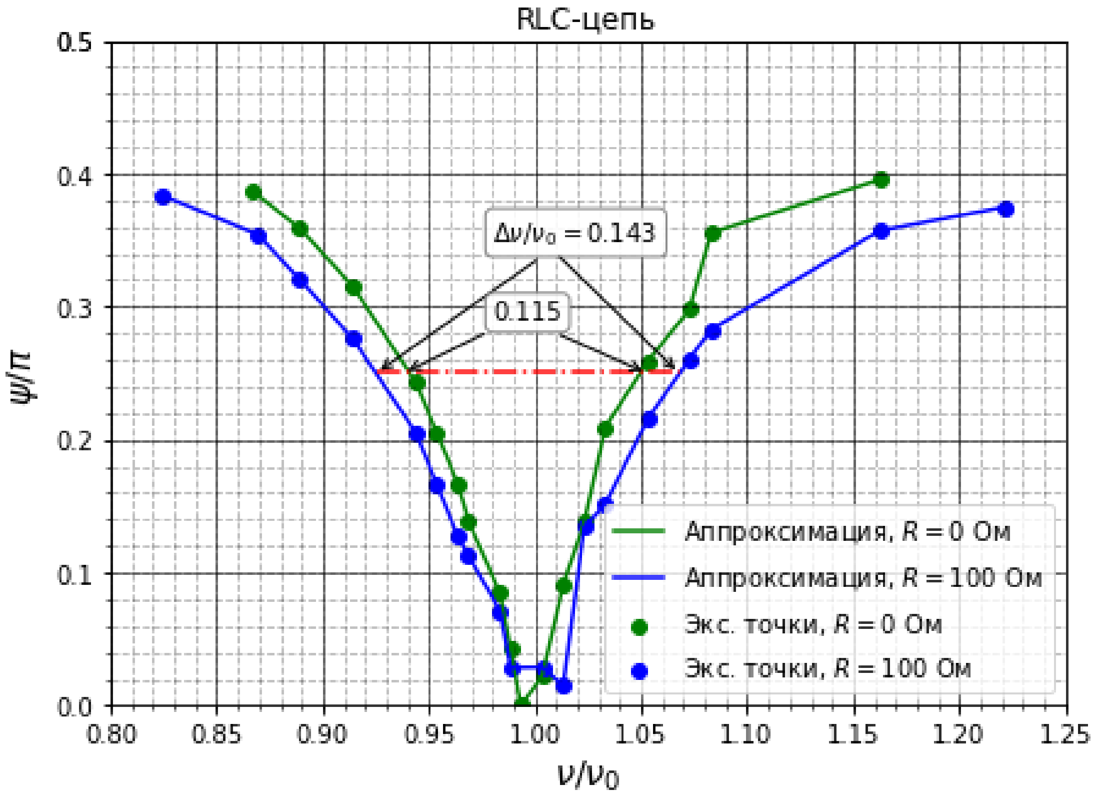
При этом $\psi = -\dfrac{x}{x_0}\pi$. Но мы будем откладывать $\dfrac{\psi}{\pi} = -\dfrac{x}{x_0}$

```
In [18]: RLC_v0 = 1006.6
         RLC_Y_0 = np.abs(-RLC_frame_0.x / RLC_frame_0.x0)
         RLC_Y_100 = np.abs(-RLC_frame_100.x / RLC_frame_100.x0)
```

```
In [19]: RLC_X_0 = RLC_0_v/RLC_v0
         RLC_X_100 = RLC_100_v/RLC_v0
```

```
In [20]: fig, ax = plt.subplots(figsize=(7, 5))

         # ДЛЯ R = 0 ОМ
         ax.scatter(RLC_X_0, RLC_Y_0, label=r'Экс. точки, $R=0$ Ом', c='g')
         RLC_f_0 = interp1d(RLC_X_0, RLC_Y_0, kind='slinear')
         RLC_X_pred_0 = np.linspace(np.min(RLC_X_0), np.max(RLC_X_0), 1000)
         ax.plot(RLC_X_pred_0, RLC_f_0(RLC_X_pred_0), label=r'Аппроксимация, $R=0$ Ом', c='g')

         # ДЛЯ R = 100 ОМ
         ax.scatter(RLC_X_100, RLC_Y_100, label=r'Экс. точки, $R=100$ Ом', c='b')
         RLC_f_100 = interp1d(RLC_X_100, RLC_Y_100, kind='slinear')
         RLC_X_pred_100 = np.linspace(np.min(RLC_X_100), np.max(RLC_X_100), 1000)
         ax.plot(RLC_X_pred_100, RLC_f_100(RLC_X_pred_100), label=r'Аппроксимация, $R=100$ Ом',
```

```python
ax.xaxis.set_major_locator(MultipleLocator(0.05))
ax.xaxis.set_minor_locator(MultipleLocator(0.01))
ax.set_xlim((0.8, 1.25))
ax.yaxis.set_major_locator(MultipleLocator(0.1))
ax.yaxis.set_minor_locator(MultipleLocator(0.02))
ax.set_ylim((0, 0.45))


# ЛИНИЯ PI/4
bbox_props = dict(boxstyle="round", fc="w", ec="0.5", alpha=0.9)
ax.plot(np.linspace(0.925, 1.068, 100), [0.25]*100, c='r', ls='-.')
ax.annotate(r'$\Delta\nu/\nu_0 = 0.143$',
            xy=(0.925, 0.25),
            xytext=(0.98, 0.35),
           arrowprops={"facecolor": "black", "arrowstyle":"->"},
           bbox=bbox_props)
ax.annotate('',
            xy=(1.068, 0.25),
            xytext=(1.01, 0.34),
           arrowprops={"facecolor": "black", "arrowstyle":"->"})

ax.annotate(r'0.115',
            xy=(0.938, 0.25),
            xytext=(0.98, 0.29),
           arrowprops={"facecolor": "black", "arrowstyle":"->"},
           bbox=bbox_props)
ax.annotate('',
            xy=(1.053, 0.25),
            xytext=(1.01, 0.28),
           arrowprops={"facecolor": "black", "arrowstyle":"->"})


ax.grid(True, 'minor', c='black', alpha=0.3, ls='--')
ax.grid(True, 'major', c='black', alpha=0.6, ls='-')

plt.yticks(list(plt.yticks()[0]) + [0.5])
ax.set_ylim((0, 0.5))
ax.set_xlabel(r'$\nu/\nu_0$', size='x-large')
ax.set_ylabel(r'$\psi/\pi$', size='x-large')
ax.set_title(r'RLC-цепь')

ax.legend(loc=4)
plt.savefig('RLC.pdf', fmt='pdf')
plt.show(fig)
```



Получаем для $R = 100$ из графика $\boxed{Q = 6.99}$

Для $R = 0$ из графика $\boxed{Q = 8.7}$