trigonometric_method

April 24, 2023

1 Trigonometrical method

Tasks: 1. numerical analysis of mechanism 2. optimization of mechanism 3. control of mechanism ## Python Intro ## Why Python -> it is free! - libraries - variables, numbers, lists … - flow control - function definition - plotting

1.0.1 Libraries

- use the available useful functions
- the functions are gather in the libraries
- the libraries are usually open-source projects
- you can download them directly (from Git etc.) or using pip (https://pypi.org/project/pip/)

```python
# The Python Standard Libraries                https://docs.python.org/3/
 ↪library/index.html
# - standard built-in, without installation
import math

# Basic library for numerical calculation      https://numpy.org/doc/stable/
 ↪user/quickstart.html
# - Numpy vs. Matlab                            https://numpy.org/doc/stable/
 ↪user/numpy-for-matlab-users.html
import numpy

# Basic library for plotting                   https://matplotlib.org/
from matplotlib import pyplot as plt
```

1.0.2 Variables, Numbers, Lists …

- you can easily define neccesary variables
- the variables are usually defined without data type definition (boolean, int, string …) - all types are objects

```python
a = 0.1 # [m]
b = 0.5 # [m]
c = 0.3 # [m]

angle_fi_0_s = 0 # [rad]
```

```python
angle_fi_0_e = 2*math.pi # [rad], pi is defined in the library math as constant
angle_fi_0_num_division = 1000 # number of sections between the angle_fi_0 and
 ↪the angle_fi_1

# using function from the imported library numpy
# each function has specified parameters
angles_fi_0 = numpy.linspace(angle_fi_0_s, angle_fi_0_e,
 ↪angle_fi_0_num_division) # get list of angles between the angle_fi_0 and the
 ↪angle_fi_1

# basic printing function - print()
# parameter can be a functional string - f''
print(f'List of angles: {angles_fi_0} rad')
```

```
List of angles: [0.         0.00628947 0.01257895 0.01886842 0.0251579
0.03144737
 0.03773685 0.04402632 0.0503158  0.05660527 0.06289475 0.06918422
 0.0754737  0.08176317 0.08805265 0.09434212 0.1006316  0.10692107
 0.11321055 0.11950002 0.1257895  0.13207897 0.13836845 0.14465792
 0.15094739 0.15723687 0.16352634 0.16981582 0.17610529 0.18239477
 0.18868424 0.19497372 0.20126319 0.20755267 0.21384214 0.22013162
 0.22642109 0.23271057 0.23900004 0.24528952 0.25157899 0.25786847
 0.26415794 0.27044742 0.27673689 0.28302637 0.28931584 0.29560531
 0.30189479 0.30818426 0.31447374 0.32076321 0.32705269 0.33334216
 0.33963164 0.34592111 0.35221059 0.35850006 0.36478954 0.37107901
 0.37736849 0.38365796 0.38994744 0.39623691 0.40252639 0.40881586
 0.41510534 0.42139481 0.42768429 0.43397376 0.44026323 0.44655271
 0.45284218 0.45913166 0.46542113 0.47171061 0.47800008 0.48428956
 0.49057903 0.49686851 0.50315798 0.50944746 0.51573693 0.52202641
 0.52831588 0.53460536 0.54089483 0.54718431 0.55347378 0.55976326
 0.56605273 0.57234221 0.57863168 0.58492115 0.59121063 0.5975001
 0.60378958 0.61007905 0.61636853 0.622658   0.62894748 0.63523695
 0.64152643 0.6478159  0.65410538 0.66039485 0.66668433 0.6729738
 0.67926328 0.68555275 0.69184223 0.6981317  0.70442118 0.71071065
 0.71700013 0.7232896  0.72957907 0.73586855 0.74215802 0.7484475
 0.75473697 0.76102645 0.76731592 0.7736054  0.77989487 0.78618435
 0.79247382 0.7987633  0.80505277 0.81134225 0.81763172 0.8239212
 0.83021067 0.83650015 0.84278962 0.8490791  0.85536857 0.86165805
 0.86794752 0.87423699 0.88052647 0.88681594 0.89310542 0.89939489
 0.90568437 0.91197384 0.91826332 0.92455279 0.93084227 0.93713174
 0.94342122 0.94971069 0.95600017 0.96228964 0.96857912 0.97486859
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 1.01889491 1.02518439 1.03147386 1.03776334 1.04405281 1.05034229
 1.05663176 1.06292124 1.06921071 1.07550019 1.08178966 1.08807914
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 1.13210546 1.13839494 1.14468441 1.15097389 1.15726336 1.16355283
 1.16984231 1.17613178 1.18242126 1.18871073 1.19500021 1.20128968
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1.50947395 1.51576342 1.5220529  1.52834237 1.53463185 1.54092132
1.5472108  1.55350027 1.55978975 1.56607922 1.5723687  1.57865817
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6.18884319 6.19513266 6.20142214 6.20771161 6.21400108 6.22029056
6.22658003 6.23286951 6.23915898 6.24544846 6.25173793 6.25802741
6.26431688 6.27060636 6.27689583 6.28318531] rad
```

1.0.3 Programme flow control

- the standard flow control tools are defined in Python https://docs.python.org/3/tutorial/controlflow.html
- programme blocks are defined by indentation

```
[ ]: # empty list of coordinates defition
     x_B = []
```

```
y_B = []

for phi_1 in angles_fi_0:
    # calculate defined values
    dis_AS2 = math.sqrt((a*math.cos(phi_1)-c)**2 + (a * math.sin(phi_1))**2)
    dis_BS2 = b - dis_AS2
    phi_2 = math.atan(a * math.sin(phi_1) / (c - a * math.cos(phi_1)))

    # append new values to existing lists
    x_B.append(dis_BS2 * math.cos(-phi_2) + c)
    y_B.append(dis_BS2 * math.sin(-phi_2))
```

1.0.4 Function definition and Plotting

- you can easily define own functions -> do it!
- decompose your code into function blocks
- add description of your function into the code
- describe inputs and outputs of the function

```
[ ]: def make_2D_graph(x, y, x_name, y_name, title):
        """
        Funtion plots the data [x, y] into 2D graph.

        param x: x data
        type  x: int
        param y: y data
        type  y: int
        param x_name: name of the x axis
        param x_name: str
        param y_name: name of the y axis
        param y_name: str
        param title: title of the graph
        param title: str
        """
        plt.figure(dpi=100)
        ax = plt.axes()
        ax.set_xlabel(x_name, labelpad=20)
        ax.set_ylabel(y_name, labelpad=20)
        ax.set_title(title)
        # plot line - parameters https://matplotlib.org/stable/api/_as_gen/
    ↪matplotlib.pyplot.plot.html
        ax.plot(x, y, 'r', linewidth=1)
        ax.grid(True)

    # example of usage the defined function
    # plot the trajectory of point B[x_B, y_B]
    make_2D_graph(x_B, y_B, 'x [m]', 'y [m]', 'Trajectory of point B')
```

Trajectory of point B