# 1 Machine Dynamics - Assignment 1

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## 1.1 Part I

### 1.1.1 Q2 Statics

**Calculate the reaction forces at all joints and the required torque on Link 2 to achieve static balance when $\theta_2$ is equal to 90 degree. List all the data in a table.**

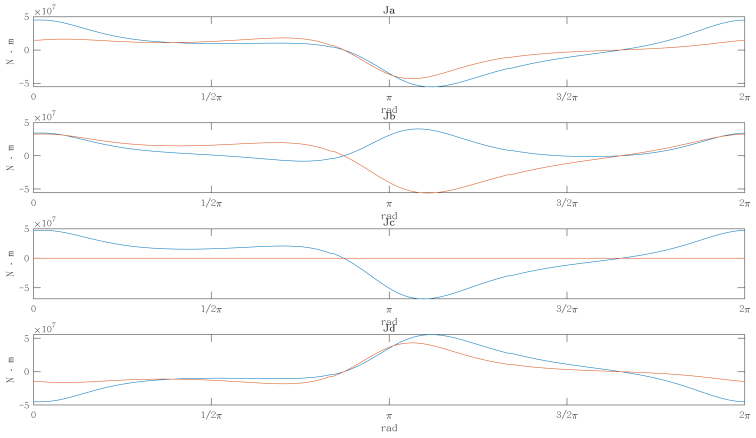
| Joint | Reaction Force ($N$) | Required Torque ($N \cdot m$) |
|---|---|---|
| A | 1035.4742 | 0 |
| B | 1036.2480 | 0 |
| C | 1036.5765 | 0 |
| D | 1044.4153 | 0 |

## 1.2 Part II

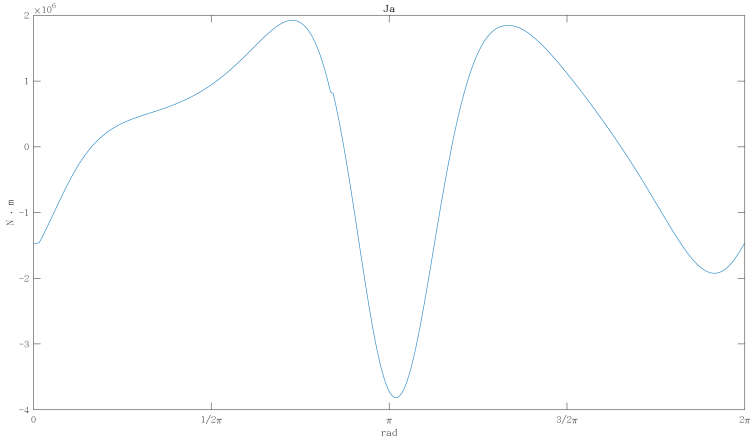
### 1.2.1 Q3 Kinetostatics

**Calculate the reaction force at all joints and the required torque on Link 2 when $\theta_2$ varies from $\theta$ to 360 degree (interval $\leq 1$ degree). Take the angle of Link 2 ($\theta_2$) as the horizontal axis to draw plots for these variables.**

The reaction forces of each joint splitted with x and y axis: (Ja ~ Jd)



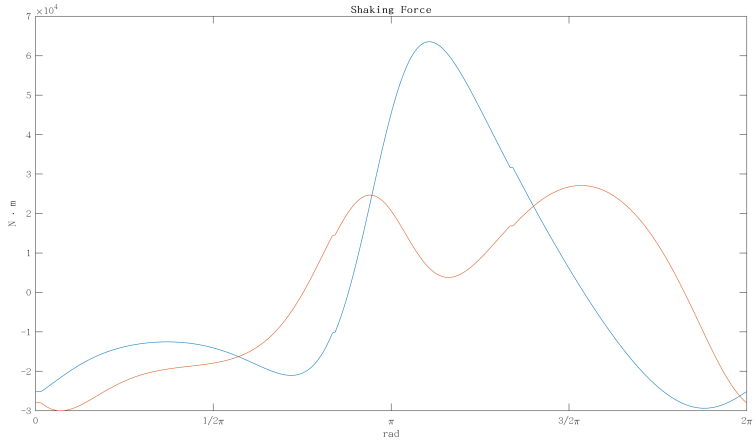

The required torque on Joint A:



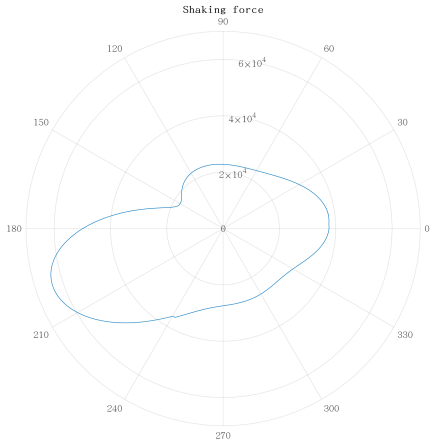

### 1.2.2 Q4

**Continued from 3, draw (a) the plots of the x and y components of the shaking force with $\theta_2$ as the horizontal axis, and (b) the polar plots of the shaking force and shaking moment.**

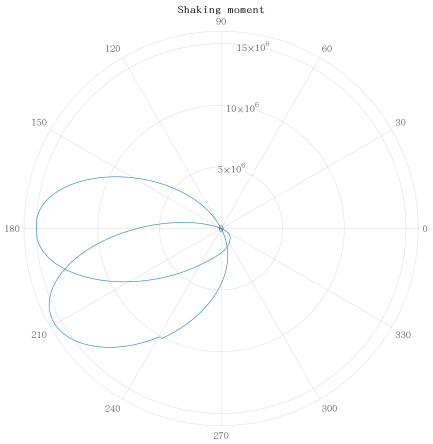
The shaking force is composed by Joint A and Joint D based on the frame.




The polar plot of shaking force. (Composed)




The shaking moment can be obtained by $M_S = \overrightarrow{R_1} \times \overrightarrow{F_{41}} + \overrightarrow{T_{21}}$.




#### 1.2.2.1 a. What is the maximum input torque? When does it happen? Use degree as the unit and be accurate to 2 decimal places.

According to the torque of Joint A, the extremum of input torque is $3.8172 \times 10^6$ $N \cdot m$ at $\theta_2 = 183.9195$ deg.

#### 1.2.2.2 b. What are the maximum shaking force and shaking moment? When do they happen? Use degree as the unit and be accurate to 3 decimal places.

According to the polar plot, the maximum shaking force is $57694.7620N$ at $\theta_2 = 199.6040$ deg; the maximum shaking moment is $1556.5653 \times 10^4$ $N \cdot m$ at $\theta_2 = 209.5842$ deg.