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 θ_2 is equal to 90 degree. List all the data in a table.

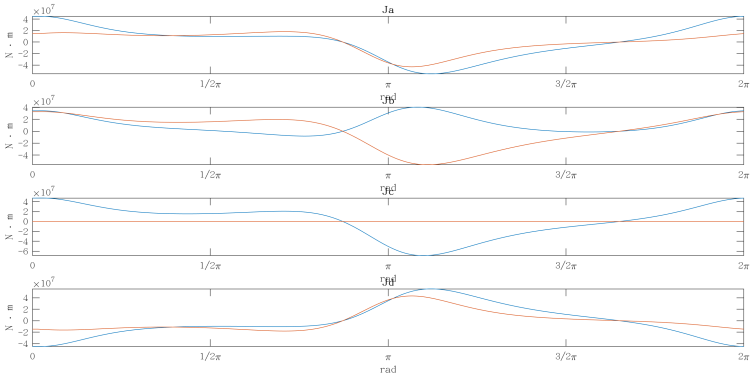
Joint	Reaction Force (N)	Required Torque ($N \cdot m$)
A	1035.4742	0
B	1036.2480	0
C	1036.5765	0
D	1044.4153	0

1.2 Part II

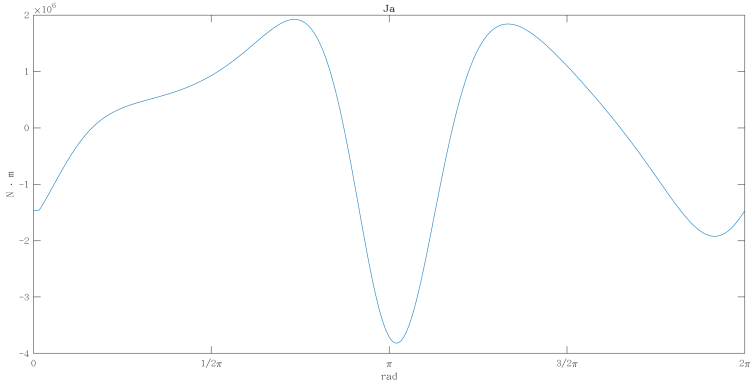
1.2.1 Q3 Kinetostatics

Calculate the reaction force at all joints and the required torque on Link 2 when θ_2 varies from θ to 360 degree (interval ≤ 1 degree). Take the angle of Link 2 (θ_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)



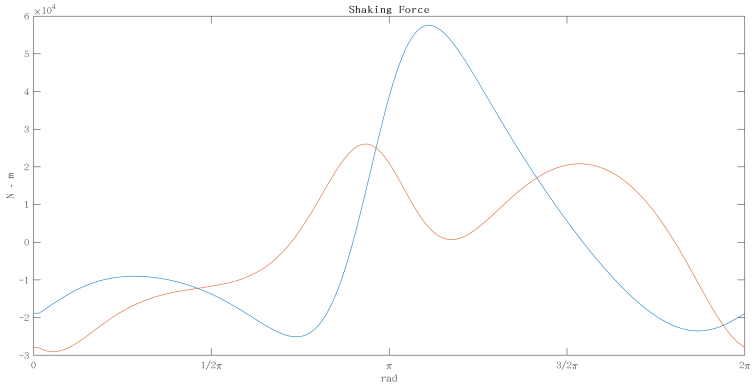
The required torque on Joint A:



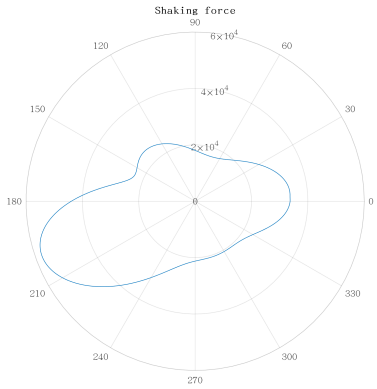
1.2.2 Q4

Continued from 3, draw (a) the plots of the x and y components of the shaking force with θ_2 as the horizontal axis, and (b) the polar plots of the shaking force and shaking moment.

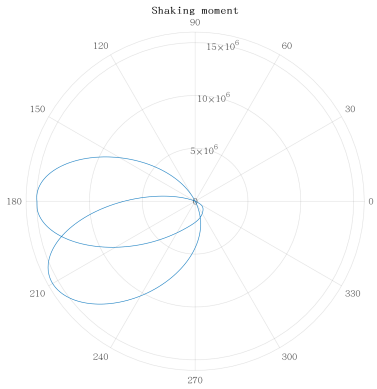
The shaking force is composed by Joint A and Joint D based on the frame.



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 3.8172×10^6 $N \cdot m$ 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 1556.5653×10^4 $N \cdot m$ at $\theta_2 = 209.5842$ deg.