ME 361 Bonus Assignment

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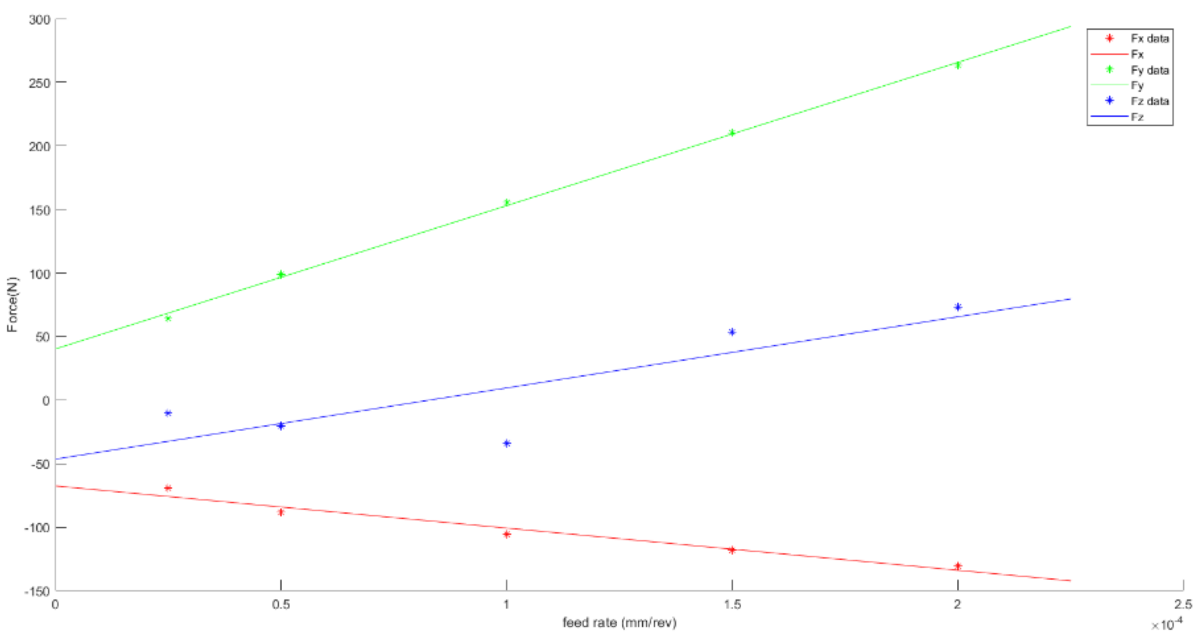
Question (i)

Conside an end mill with 20 mm diameter, 4 flutes, a 30◦ helix angle, and 10◦ rake angles is used in the peripheral milling of aerospace wing support frames. The material is Al-7075. A series of full-immersion (i.e., slot) milling experiments are conducted at constant speed (2,500 rev/min) and axial depth of cut (a = 1.5 mm), but at a series of feed rates. The cutting forces are measured and the average forces per tooth period are given in Table 2.4 – taken from the book by Prof. Altintas that we are referring to in the class.

TABLE 2.4. Measured Average Milling Forces for Al7075

Feed Rate [mm/th]	$\bar{F}_x$ [N]	$\bar{F}_y$ [N]	$\bar{F}_z$ [N]
0.025	−69.4665	64.3759	−10.2896
0.050	−88.1012	99.1383	−20.5814
0.100	−105.6237	155.7100	−33.9852
0.150	−118.1107	210.4644	53.4833
0.200	−130.6807	263.4002	73.1515

Given above is the data as given in the question with varying feed rates per teeth. Plotting the above Forces(F_x, F_y, F_z) with respect to feed rate we can plot a best fit line curve using MATLAB to find out cutting and edge constants.



Cutting constants

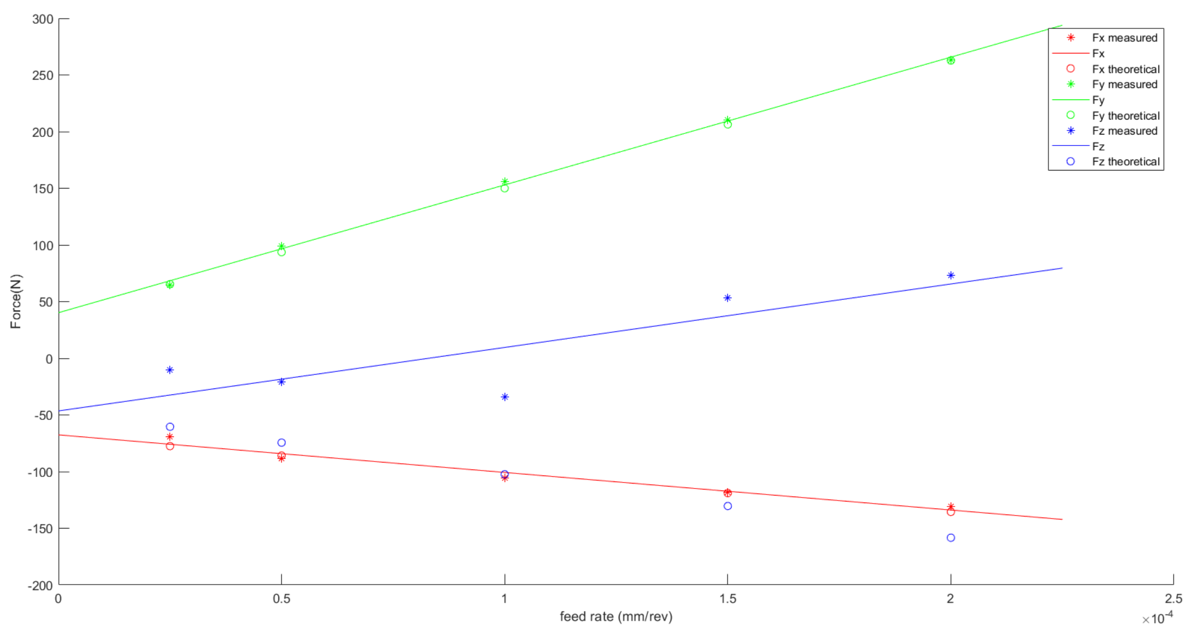
K_{tc} = 7.5163×10^8 N/m^2
K_{rc} = 2.2109×10^8 N/m^2
K_{ac} = -2.9324×10^8 N/m^2

Edge constants

K_{te} = 2.1064e×10^4 N/m^2
K_{re} = 3.5381e×10^4 N/m^2
K_{ae} = -1.5483×10^4 N/m^2

Question (ii)

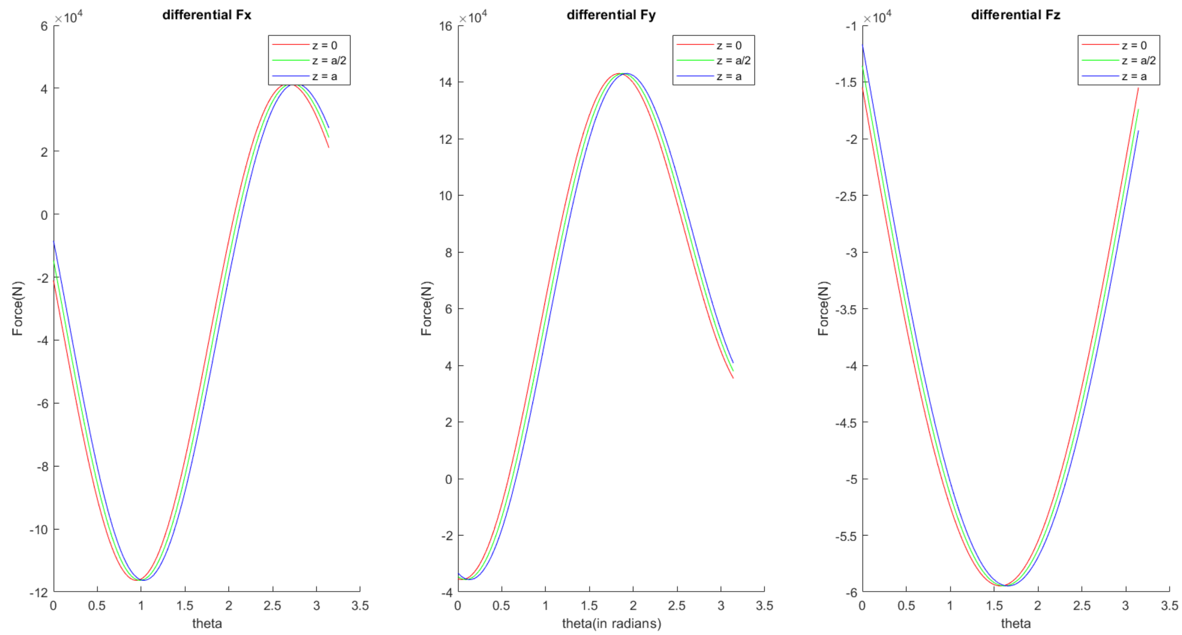
Feed rate (mm/teeth)	F_x (measured)	F_x (theory)	F_y (measured)	F_y (theory)	F_z (measured)	F_z (theory)
0.025	-69.4665	-77.5220	64.3759	65.4474	-10.2896	-60.4345
0.050	-88.1012	-85.8130	99.1383	93.6336	-20.5814	-74.4185
0.100	-105.6237	-102.395	155.7100	150.0060	-33.9852	-102.386
0.150	-118.1107	-118.977	210.4644	206.3784	53.4833	-130.354
0.200	-130.6807	-135.559	263.4002	262.7508	73.1515	-158.322



Plot of measured vs theoretical data

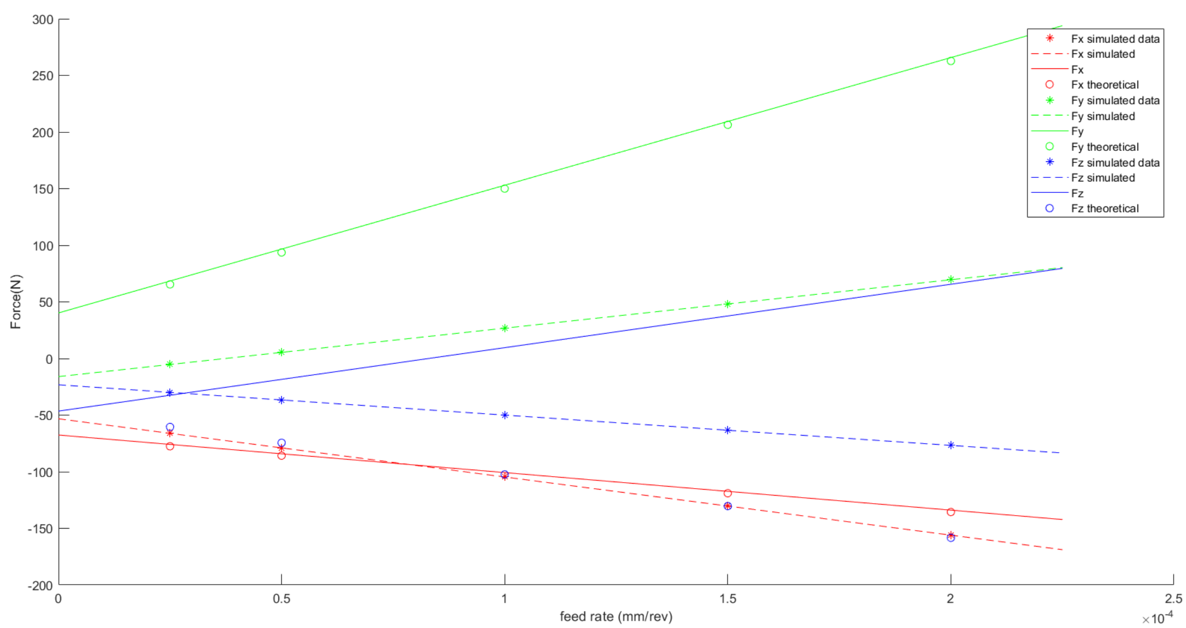
Major discrepancy arrives in the value of F_z
Reasons for discrepancy in the measured vs theoretical data van be explained by :

- Chip accumulation of the cut-out chips on the surface.
- Microscopic Adhesive bonding between the milling tool and the work piece.
- Vibration while the CNC is in operation.

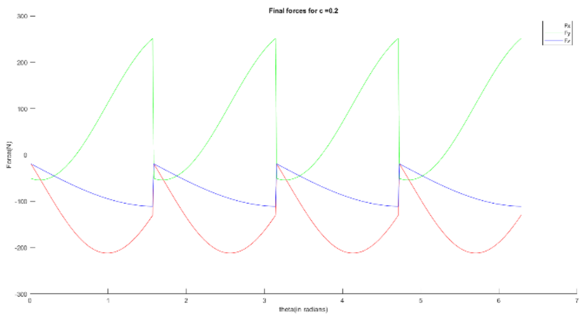


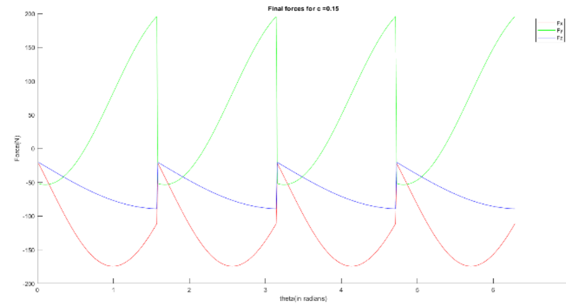
The above graph shows the variation of differential forces as a function of variable theta(measured in radians) for 3 different z i.e., z = 0, z = a/2, z = a

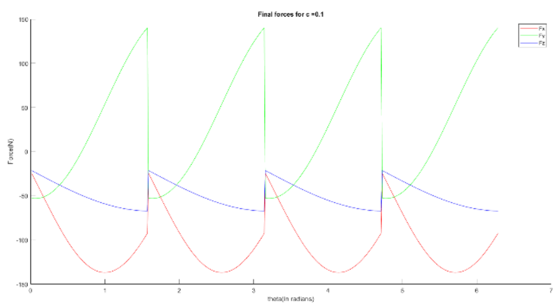
Question (iii a)

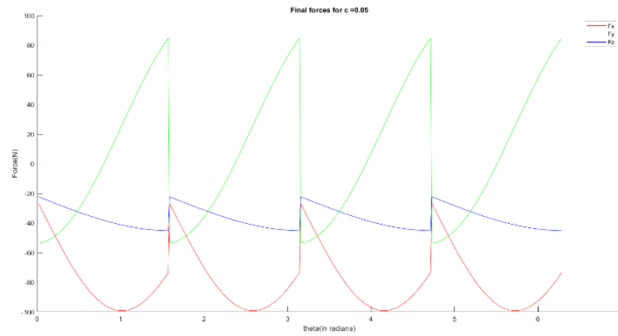


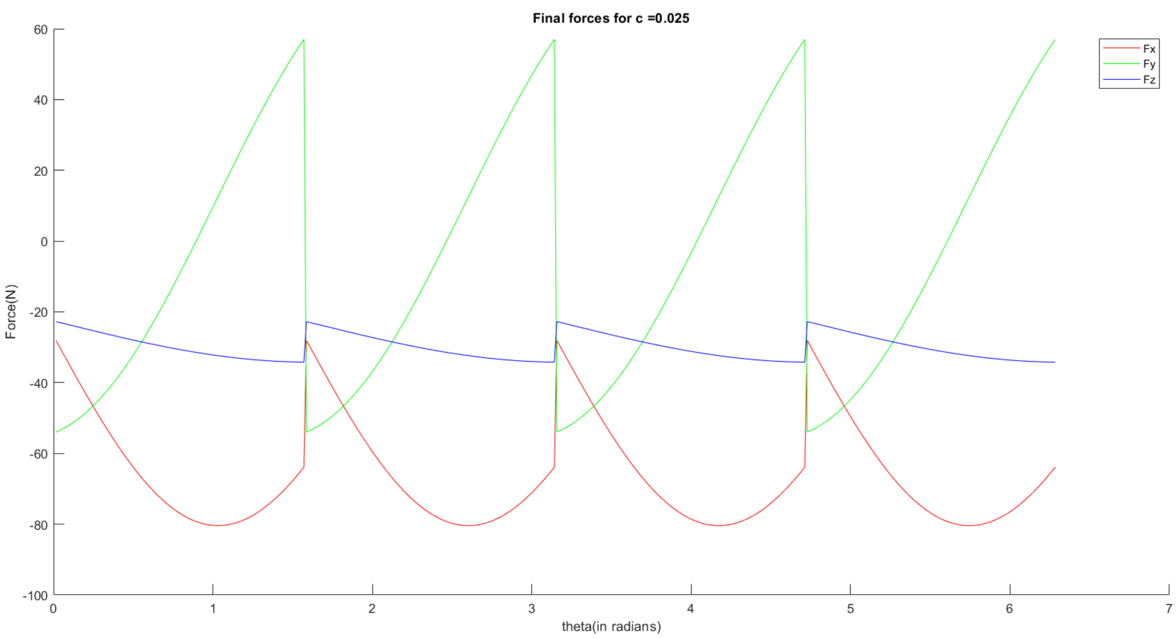
This is the graph for the half milling forces for all the cases of all the feed rates for the case of up milling.







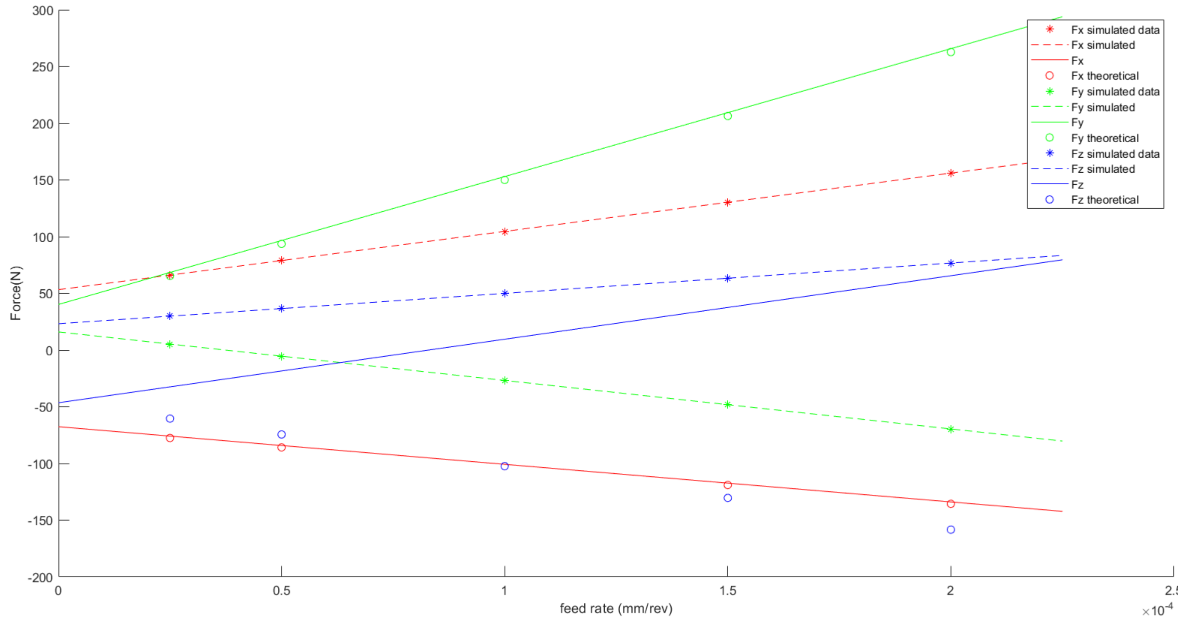




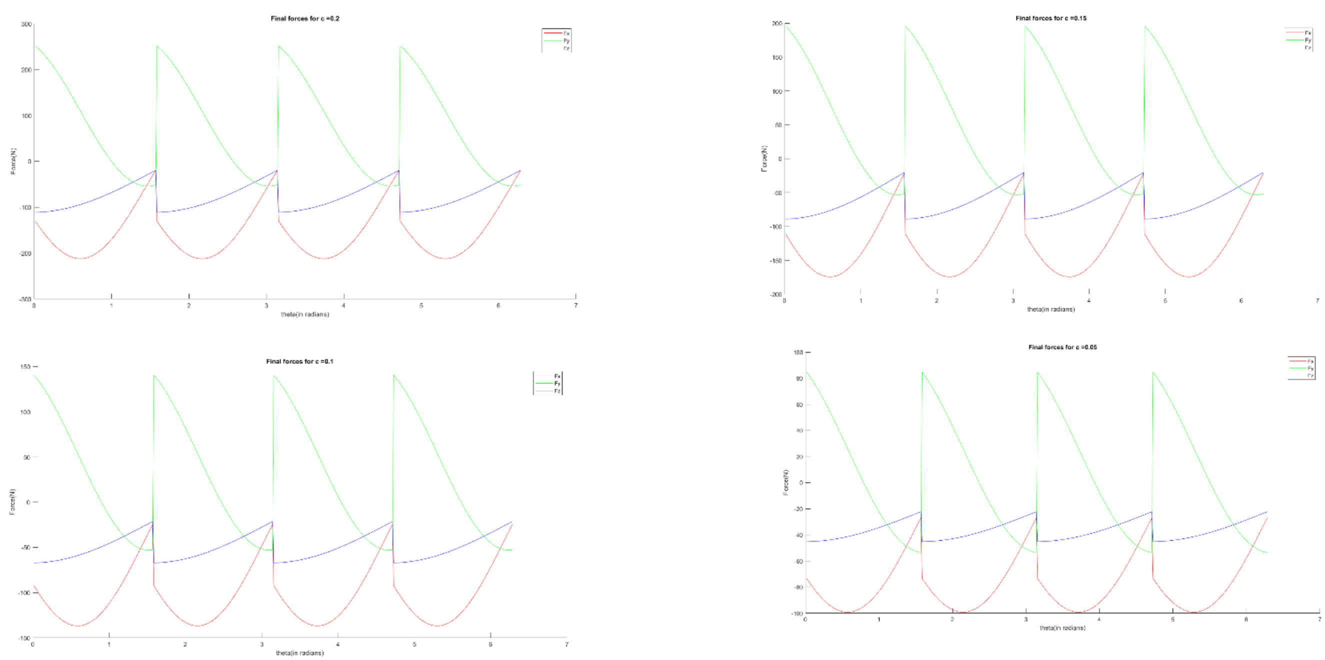
The above graph shows the upmilling forces at different feed rates for x, y, z directiosns.

In up milling the chip load is minimum at entry when the flute enters the material and it increases to a maximium at the exit point.

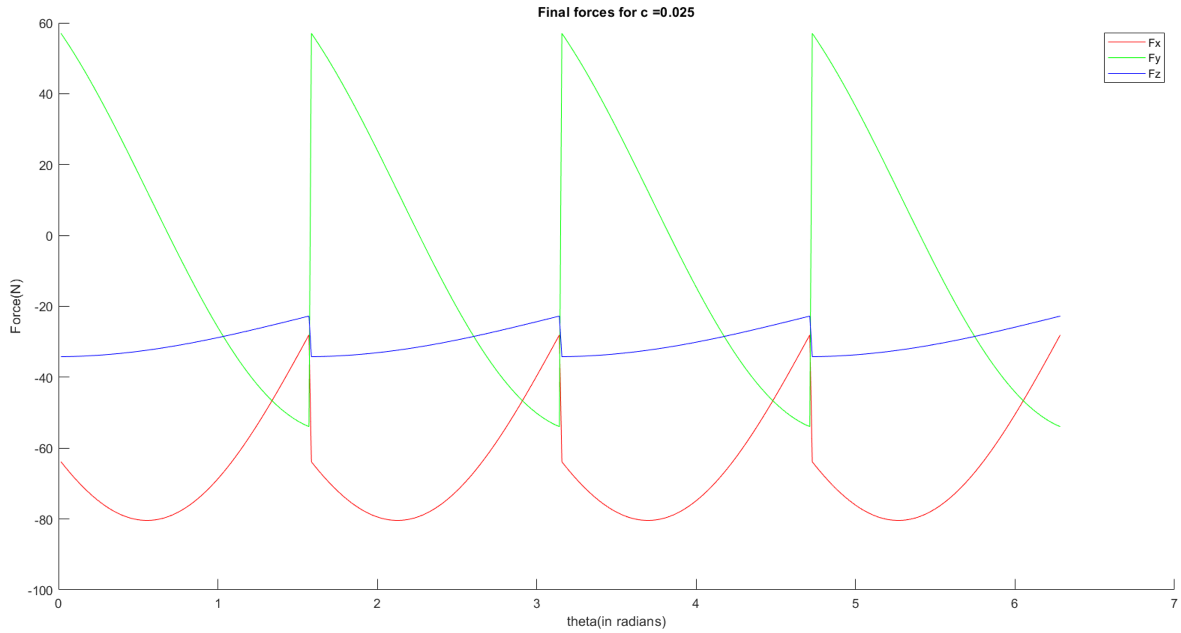
Question (iii a)



This is the graph for the half milling forces for all the cases of all the feed rates for the case of up milling.



In down milling the chip load is maximum at entry when the flute enters the material and it decreases to a minimum at the exit point.



Final forces for c =0.025
Fx
Fy
Fz
Force(N)
theta(in radians)
60
40
20
0
-20
-40
-60
-80
-100
0
1
2
3
4
5
6
7