CHAPTER III

CATCULATION OF THE MODE SHAPE AND FREQUENCIES

We use inverse interpolation and linear interpolation to find the mode shapes and frequencies. Suppose we have a function y = f(x) from which for a given value of x_i a value y_i is assigned. To find x when some y_j is given $(i \neq j)$ we use inverse interpolation. If x_j is given $(i \neq j)$ then we use direct interpolation to find y.

The calculation is done in the following steps: 1. Fix F, and determine the value of y_1 that makes $y'_{10} = 0$, by using inverse interpolation.

Repeat the calculation for different frequencies F.
 The results obtained are in Table 15 - 22.

3. From the Table 15 - 22 calculate the corresponding value of $y_{10}^{''}$ by using direct interpolation. This gives $y_{10}^{''}$ as a function of F, when $y_{10}^{\prime} = 0$. Results to are shown in Table 23 - 30.

4. Determine the frequency F for which $y_{10}^{''} = 0$, using inverse interpolation. This is the vibration frequency, and the corresponding values of $y_0, y_1, y_2, \dots, y_{10}$ give the shape of the mode. The result obtained is F = 1289 H_g (Hertz), see table 31.

Calculation the value of y_1 that makes $y_{10}'' = 0$, where F = 1000

xio -	T 1	1	2	3	4	5
-0.3161:0	-1.0	All marking	100			Sec. S
-0,13930	-0.9	-0.8213439				
0,03765	-0.8	-0.8212851	-0.8212976			
0.21470	~0.7	-0.8212766	-0.8213174	-0.8212771		
0.39170	-0,6	-0,8212618	-0.8213224	-0.8212799	-0.8212737	
0.56870	-0.5	-0.8212631	-0.8213280	-0.8212810	-0.8212747	-0.821271

 $T = 1000, DF = 100, T_4 = -1.0, DT_4 = 0.1$

Since $y'_{10} = 0$ the laft-hand column contains the "parts" used in the process. We obtain $y_1 = -0.0212716$.

Thble 16

F = 1100, DF = 100, 74 = -1.0, DF = 0.1

J'10	74	1	2	3	4	5
-0.38450	-1.0		-		sectional 2	
-0.19110	-0.9	-0.8011892	and of the	and all		the second s
0.002268	-0.8	-0.8011728	-0.8011730			
0.19560	-0.7	-0.8011550	-0.8011723	-0.8011731	ALC: A	N.
0.3890	-0.6	-0.8011635	-018011807	-0.8011750	-0.8011732	
0.5825	-0.5	-0.8011892	-0,8011892	-0.8011729	-0.8011732	-0.8011732

JA = -0.8011732

 $P = 1300, DP = 100, y_1 = -1.0, Dy_1 = 0.1$

50

J10	34	1.1.7	2	3	4	5
-0.5haho	-1.0		and the state	and the second		
-0-31130	-0.9	-0.7652964				
-0,08031	-0.8	-0.7652405	-0.7652211		5	
0.15070	-0.7	-0.7652490	-0.7652615	-0.7652362		
0.38480	-0,G	-0.7652156	-0.7652736	-0.7652202	-0.7652401	
0.61280	-0.5	-0.7652355	-0.7652759	-0.7652274	-0.7652392	-0.765241
Contraction of the second s	Proprietory and the state of the state of	Compression and an average services	protect and a second second real of	and which as an end of the second second		Study was an dealer with the barrant

y10 = 0

NAMES OF STREET, STREE

Ja = -0.7652418

 $T = 1200, DF = 100, y_q = -1.0, Dy_q = 0.1$

710	74	1	2	3	4.	5
-0_1598	-1.0		Sec. 1			- Anne
-0.2484	-0.9	-0,7824976				
-0.0370	-0,8	-0.7821976	-0.7824976	1 Courses		
0*174	-0.7	-0.7821976	-0.7821976	-07821:976		
0.3858	-0,6	-0.7824976	-0.7821976	-0.7821976	-0.782:976	
0.5972	-0.5	-0.7824976	-0.7821:976	-0.7821,976	-0.7821:976	-0.7824976

310 = 0

74 = -0.7824976

alle

21

 $P = 4000, DF = 100, y_1 = 1.0, Dy_1 = 0.1$

J40	y y	Anna	2	3	4	5
-0.6326	-1.0	in manageria			Conne de	
-0,3202	-0.9	-0.7493664			e contra los terrar	manin
-0.1278	+0.8	-0,7493661	-0.74:93661		1	
0.1215	-0.7	-0.7493330	-0.7493661	-0.7493664		
0.3769	-0,6	-0.7493413	-0.7493536	-0.7493629	-0.7493677	
0.6293	-0.5	-0.7493462	-0.7493586		-0.7493664	-0.7493690

J4 = -0.7493696

Table 20

 $\ddot{P} = 1500, DF = 100, y_1 = 1.0, Dy_1 = 0.1$

Vio	V1	1	2	3	4	5
-0.7305	-1.0				14	
-0.1:550	-0.9	-0.7318457		-Toti - All		
-0.1796	-0.8	-0.7317976	-0.7347662	(interest		
0.09576	-0.7	-0.7347687	-0.7347821	-0.7347766		1.0
0.3711	-0.G	-0.73474.95	-0.7347927	-0.731:7748	-0.732:7772	order the sup-
0.6466	-0.5	-0.7347687	-0.7348139	-0.7317766	-0.7307766	-0.734777

74 = -0.7347778

 $F = 1600, DF = 100, y_1 = -1.0, Dy_1 = 0.1$

J10	21		2	3	4	5
-0.8364	-1.0	Sala September			a. arrent	
-0.5362	-0.9	-0.7213857		THE REAL	artister (
-0.2360	-0.8	-0+7213857	-0.7213852			
-0.06b14	-0.7	-0.7213671	-0.7213.707	-0.7213737	and the	
0.393	₩0. 6	-0.7213625	-0.7213719	-0.7213730	-0.7213727	
0.6645	-0.5	-0.7213674	-0.7213774	-0.7213832	-0.7213726	-0.721372

J4 = -0.7213728

F = 1700, DF = 100, Ja = -1.0, Dy = 0.1

710	V 4	1		. 3	4	5
+0.9505	-1.0				Sec. 2	
-0.6238	-0.9	-0.7090629			14	
-0.2974	-0.3	-0.7090603	-0.7090579			Section 1
0.02954	-0.7	-0.7090424	-0.7090757	-017090740	C. Same	
0.3562	-0.6	-0.7090380	-0.7090171	-0.7090530	-0.7090758	
0.6829	-0.5	-0.7090424	-0.7090531	-0.7090564	-0.7090747	-0.7090770

J10 = 0

JA = -0.7090770



Calculation the value of $y_{10}^{\prime\prime}$ corresponding to

y4 = -0.8212716

 $P = 1000, y_1 = -1.0, Dy_1 = 0.1, 1 = 0, 1, 2, ---5$

11.1.1	34	Ja - Ja	740	1	2	3	4	5
111111	-	0.1787284		a raine				
	-0.9	0.0787284	-0.01166	-0.0040233				1 1 2
	+0.8	-0.0212716	-0.001961	-0,001,0233	-0.0000233		12.4.2.1	
	-0.7	-0.1212716	0.007744	-0.001:021:8	-0.0010230	-0.0040234		
	-0.6	-0,2212716	0.01744	-0.0040211	-0.0010295	-0.0010226	-0.001:021:4	
	-0.5	-0.3212716	0.02744	-0.0040233	-0.001,011,2	0.0040239	-0.001;0234	-0.004027

0

 $y_{0} = y_{1} = -0.8212716$ $y_{10}'' = -0.0010272$

F = 1100, yq = -1.0, Dyq = 0.1, 1 = 0,1,2---,5

71	y ^a - 2 ⁷	J''10	1	2	3	ALL BARRE	5
-1.0	0.1988267	-0.02658				S. And	
-0.9	0.0988267	-0.011:73	-0.0030150	inisia i			1.1.1.1.3
-0.8	-0.0011733	-0.002875	-0.0030131	-0.0030131		an in a fair a	
-0.7	-0.1011733	0.00898	-0.0030404	-0,0030131	-0,0030131	- Alberta	unante h
-0.6	-0,2011733	0.02083	-0.003011:7	-0,0030193	-0,0030131	-0,0030131	
-0.5	-0.3011733	0.052690	-0.0030292	-0.0030104	-0.0030131	-0.0030131	-0.0030131

- y'10 = 0
- Jo = J = -0.8011733
 - y'10 = -0.0030131

 $y = 1200, y_1 = -1.0, Dy_1 = 0.1, 1 = 0, 1, 2, ---5$

71	Jo - Ji	J'10	1	2	3	4	5
-1.0	0.2175024	-0.02259			1		
-0.9	0.1175024	-0.01833	-0.001574	1.1		erena i da	1
-0.8	0.0175024	-0.001:078	-0_0015035	-0.0015851			
-0.7	-0.0824976	0.01018	-0.00158.5	-0.0015822	-0.0015846		
-0.6	-0.1824976	0.021111	-0.0015842	-0.0015811	-0.0015833	-0_0015857	
-0.5	-0.2824976	0.03870	-0.0015842	-0.0015820	-0.0015814	-0.00\$5901	-0.0015771

$$y'_{10} = 0$$

 $y_{10} = y_{1} = -0.7821976$
 $y''_{10} = -0.0015771$

 $P = 1300, y_{q} = -1.0, Dy_{q} = 0.1, 1 = 0, 1, 2-5$

7 1	Ve - VA	J'10	1. Secondaria	2	3	4	5
-1.0	9.2347130	-0.03948	the mark	1999-11-1		ar en en esta	10 N 1 1 1
-0.9	0.1347130	-0.02255	0.0002569			departuro	togeneration in
-0.8	0-0347130	-0.005626	0.0002188	0.0002380	a constants	an al surray	a que trances
-0.7	-0.0652870	0.01130	0.00021;95	0.0002190	0.0002348		
-0.6	-0.1652870	0.02823	0.0002169	0.0002512	0.00021:76	0.0002215	
-0.5	-0.2652870	0.04516	0.0002469	0,00021/69	0.00002583	0.0002299	0.0002176

$$y'_{10} = 0$$

 $y_0 = y_1 = -0.7652870$
 $y'_{10} = 0.0002176$

F=1400, y = -1.0, Dy = 0.1,1=0, 1,2,....5

							and the second sec
71	70- 71	F ^{et} F1 0	1	2	3	4	5
-1.0	0.2506304	-0.04733	196				-
-0.9	0.1506304	-0.02745	0.0024853				
-0.8	0.0506304	-0,00758	0.0021785	0.0024751		1.00	
-0.7	-0.0493696	0.01229	0.0034825	0.0024802	0.0024778		
-0.6	-0.11:93696	0.03216	0,0024803	0.0024836	0.0094790	0.0024772	
-0.5	+0.2493696	0.05204	0.0024653	0.0025027	0.0024804	0.00254157	0.0024772
		and the second sec	Contraction of the second statement of the second sec	And the second se	and the second state of th	COLUMN TWO IS NOT THE OWNER.	Street, Square, and statistics.

y₁₀= y₁ = -0.7493696

340 = 0.6024772

Tablo 28

F=1500, y1= -1.0, Dy1= 0.1, 1=0, 1,2,...5

y1	ys- yi	J''10	1	2	3	4	5
-1.0	-0.265222	-0.05623				1	
-0.9	-0.165222	-0.03312	0.0050628			1.	
-0.8	-0.065222	-0.01000	0.0050761	0.0050842			1.1
-0.7	0.034778	0.01310	0.0050618	0.0050619	0.0050697		
-0.6	0.134778	0.03621	0.0050628	0.0050628	0.0050772	0.0050671	1. 19
-0.5	0.234778	0.05933	0.0050681	0.0050650	0.0050800	0.0050679	0.0050660

 $y'_{10} = 0$ $y_{0} = y_{1} = -0.734778$ $y''_{10} = 0.0050660$

F=1600, ya= -1.0, Dya= 0.1, 1=0, 1, 2,5

71	Jor Jg	340	1	2	3	4	5
-1.0	0,2786272	-0.06630	1				
-0.9	0.1786272	-0.03964	0.0079820				
-0.8	0.0786272	-0.01298	0.0079820	0.0079820			
-0.7	-0.0213728	0.01367	0.0079760	0.0079770	0.0079780		
-0.6	-0.1213728	0.04033	0.0079720	0.0079770	0.0079770	0.0079780	
-0.5	-0,2213728	0,06700	0.0079600	0.0079870	0.0079830	0.0079820	0.0079732

540ª 0

Jo= Ja = -0.7213288

340= 0.00797316

F=1700, yq = -1.0, Dyq = 0.1, 1 = 0, 4, 2,...5

ALC: NOT THE OWNER.	to the first group by a property of	adder vormanitärik aterenigente Farminette	Distantial Including the rest of the local distance of the local d	the same in the same of the	states and the second states of the second states o	A DESCRIPTION OF TAXABLE PARTY.	A Design of the local division of the local
¥1	Je- 91	y40	1	2	3	4	5
-1.0	0,2909230	-0+07765			1.1.1		
-0.9	0.1909230	-0.04711	0.0111979		12010	1.1.1.1.1.1	1.11
-0.8	0.0909230	-0.01658	0+0111788	0.0111614			
-0.7	-0.0090770	0.01395	0.0111788	0.0111788	0.0111772		
-0.6	-0.1090770	0.04448	0.0111788	0.0111788	0.0111788	0.0111771	1.000
-0.5	-0.2090770	0.07502	0.0111804	0.0111895	0.0111699	0.0111775	0.0111770
And Man Property lies, Name of Street, or other	a planter or an experiment, the second second	And International Contraction of the International Contractional Contr	THE REPORT OF AN ADDRESS OF THE PARTY OF	The state line was a special provided by which	procession and the second s	processing the second data product	the second s

J10 = 0

y.= y.= -0.7090770

340= 0.0111770

Calculation the value of F that makes $y_{40}^{\prime\prime} = 0$

340	P	1	2	3	4	5	6	7
0.0111770	1700	1351						
0.0079732	1600	1351						
0,0050660	1500	1334	1304					
0.0024772	1400	1315	1299	1294				
0.0002176	1300	1292	1290	1289	1289			
-0.0015774	1200	1262	4277	1283	1287	1289		1.00
-0.0030131	1100	1227	1261	1277	1286	1289	1289	
-0.0000272	1000	1185	1211	1269	1284	1289	1289	1289
integration of integration on the later star fails and	COLUMN TWO IS NOT THE	AND AND PROVIDE AND THE OWNER WHEN	CONTRACTOR OF TAXABLE		the rest of the second	And the lot of the lot	the second second second	- laure and and

We obtain F = 1289

5. Then we find $y_4 = -0.76710bl_1$, by using inverse interpolation, for F = 1289 H₂ which is shown in the Table 32. 6. This frequency F = 1289 H₂ is the vibration frequency, for which $y_{10}^{\prime\prime} = 0$, and the corresponding values of $y_0, y_1, y_2 \cdots y_{10}$ can be obtained as follows:

From the equations (8) and (9)

$$y_{4} = -y_{-4} = -0.7674044$$

$$z_{4} = \frac{CE^{2}a_{0}y_{0}}{2}, \text{ for the from } C = 0.185 \times 10^{-9}$$

$$\frac{C}{2} = 0.925 \times 10^{-10}$$

$$CE^{2} = 0.0003078$$

$$\frac{CE^{2}}{2} = 0.0004537$$
Ethem $z_{4} = 0.0004537$ (1). (-1.0)

= -0,0001537

By using the relations(6) and (7) we obtain

$$y_{2} = \frac{z_{4}}{(a_{4})^{3}} + 2y_{4} - y_{0}$$

= $\frac{-0.0004537}{(1.0)^{3}} + 2(-0.7671044) - (-4)$
= -0.5343625
 $z_{2} = 05^{2} a_{4}y_{4} + 2z_{4} - z_{0}$
= -0.0005435

and so on. The table of these results is shown below, table 33.

Calculation the value of y_1 corresponds to F = 1239

Fi	F - H1	y4	1	2	3	4	5
1000	289	-0.8212715					1
1100	189	-0.8011732	-0.7631874			Presentation	North La
1200	89	-0.7824976	-0.7652132	-0.7670728	en resigning for	n miner	
1300	-11	-0.76524:18	-0.7673296	-0.7671018	-0.7670986		121
1400	-111	-0.7493696	-0,7693224	-0.7670525	-0.7670618	-0.7671026	
1500	-211	40.7317778	-0.7712781	-0.7670103	-0.7670543	-0.7671010	-0.767104

J = -0.7671044

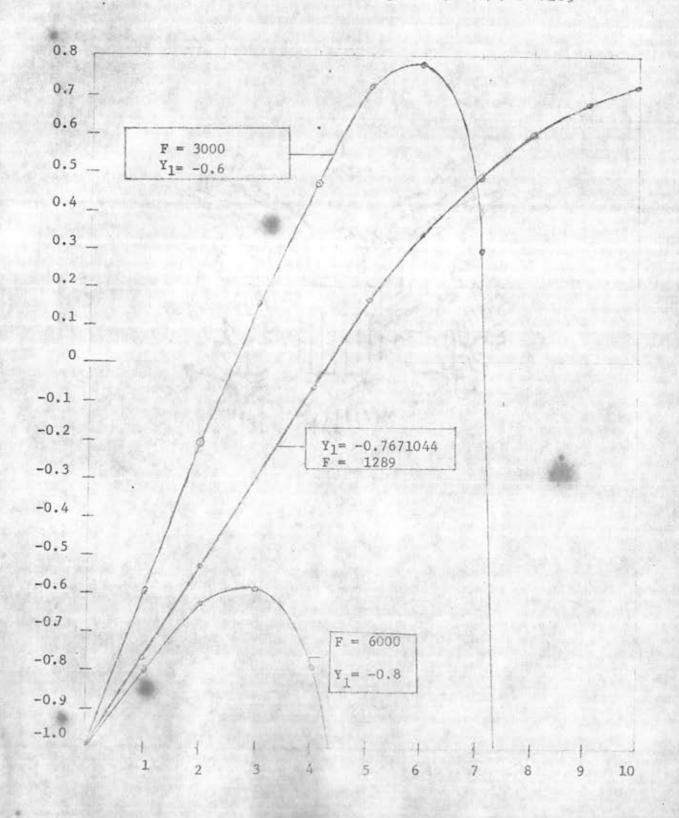
Values of y1 and Z1, 1=0, 1, 2, 3 10, corresponding to F=1289, y1 = -0.7671044

1	Zi+1=CF2e171+ 221- 2	1-1 JIH " (a) 3 + 241- JI-1
0	Z0# 0.0000000	y₀= -1.0000000
1	24= -0.0001537	Ja= -0. 7674044
2	Z2= -0.0005435	¥2 ⁼⁼ -0+5343625
3	23= -0.0010978	73= -0.3021641
4	Z24= -0.0017451	¥1,= +0.0710635
5	Z5= -0.0024143	y5 0.1582920
6	Z6= -0,0031200	V6m 0.3304196
7	87= -0.0037748	yy= 0.4775872
8	Z8= -0.0043561	78th 0,5945564
9	29= -0.0048459	yg= 0.6766768
10	Z40-0.0091521	y40= 0.7200300

They are represented in graphical form in the Figure (1.)



Node Shape of the actually frequency, F=1289



CONCLUSION



For the non-uniform bar case we can find the made shope by using the difference equation and the given parameters varying along the bar length. From the derived table one can obtain the made shape by using the interpolation and inverse interpolation method.

Thus by using the numerical method with the aid of a computer and a deak calculator we can obtain the mode shape and its natural frequencies. These results are useful in finding the evertence of musical instruments for which the cross-section is non-uniform.