

September 1, 1969

9100B STRUCTURES PROGRAM LISTING

74203 - CANTILEVER BEAM - INTERMEDIATE LOAD
 Calculates shear, moment, and deflection.



74204 - CANTILEVER BEAM - TRIANGULAR LOAD
 Calculates shear, moment, and deflection.

74205 - COORDINATES OF EQUALLY SPACED POINTS ON A CIRCLE
 Computes the rectangular coordinates of equally spaced points on a circle given the center point coordinates, radius and offset angle of the circle, and the number of coordinate points desired on the circle.

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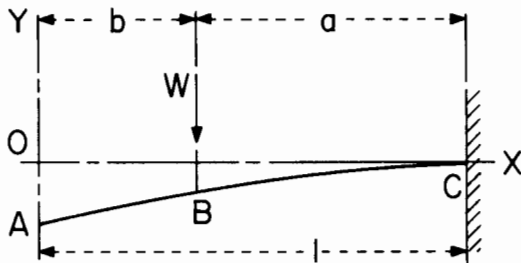


PART NO.
09100-74203

CANTILEVER BEAM INTERMEDIATE LOAD

This program computes the shear, moment, and deflection reactions for a cantilever beam with a concentrated intermediate load as given by:

CANTILEVER, INTERMEDIATE LOAD



Reaction R_2 and Vertical Shear V	Bending Moment M and max bending moment	Deflection y , maximum deflection, and end slope θ
$R_2 = +W$	(A to B) $M = 0$	(A to B) $y = -\frac{1}{6} \frac{W}{EI} (-a^3 + 3a^2l - 3a^2x)$
(A to B) $V = 0$	(B to C) $M = -W(x - b)$	(B to C) $y = -\frac{1}{6} \frac{W}{EI} [(x - b)^3 - 3a^2(x - b) + 2a^3]$
(B to C) $V = -W$	Max $M = -Wa$ at C	Max $y = -\frac{1}{6} \frac{W}{EI} (3a^2l - a^3)$ $\theta = +\frac{1}{2} \frac{Wa^2}{EI}$ (A to B)

NOTATION:

W = Load (lb)

M = Positive when clockwise

V = Positive when upward

Y = Positive when upward

θ = Radians = Tan θ

All forces are in pounds, all moments in inch-pounds, all deflections and dimensions in inches.

Reference: Formula for Stress and Strain
by R. J. Roark

McGraw - Hill Book Company 1965

USER INSTRUCTIONS

ENTER PROGRAM (Starting address is 0 - 0)

PRESS: GO TO (0) (0) [or END]

PRESS: CONTINUE

DISPLAY

0	—	Z
0	—	Y
1	—	X

ENTER: 1 → Z, a → Y, b → X

PRESS: CONTINUE

DISPLAY

0	—	Z
0	—	Y
2	—	X

ENTER: E → Z, I → Y, W → X

PRESS: CONTINUE

DISPLAY

0	—	Z
0	—	Y
3	—	X

ENTER: x → X

PRESS: CONTINUE

DISPLAY

R_2	—	Z
V_{AB}	—	Y
V_{BC}	—	X

PRESS: CONTINUE

DISPLAY

M_{AB}	—	Z
M_{BC}	—	Y
M_{MAX}	—	X

PRESS: CONTINUE

DISPLAY

0	—	Z
Y_{AB}	—	Y
Y_{BC}	—	X

PRESS: CONTINUE

DISPLAY

0	—	Z
Y_{MAX}	—	Y
θ	—	X

EXAMPLES

LET 1 = 100
 a = 60
 b = 40
 E = 10^6
 I = 20
 W = 1000
 x = 24

THEN R_2 = 1000
 V_{AB} = 0
 V_{BC} = -1000
 M_{AB} = 0
 M_{BC} = 16000
 M_{MAX} = -60000
 Y_{AB} = -5.040
 Y_{BC} = -5.006
 Y_{MAX} = -7.200
 θ = .090

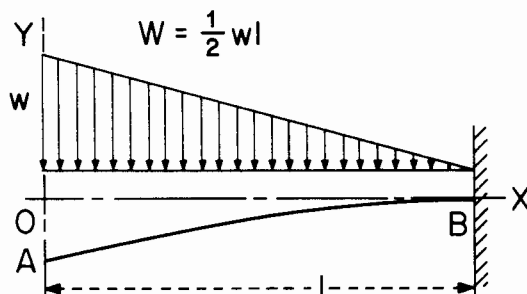
HEWLETT-PACKARD

Step	Key	Code	Display			Storage					
			x	y	z	f	e	d	c	b	a
9	0	b	14								
	1	↑	27								
	2	E	12								
	3	X	36								
	4	X	36								
	5	2	02								
	6	÷	35								
	7	CLEAR X	37								
	8	ROLL ↓	31								
	9	END	46	θ	Y _{MAX}	0					
	a										
	b										
	c										
	d										
	0										
	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	a										
	b										
	c										
	d										
	0										
	1										
	2										
	3										
	4										
	5										
	6										
	7										
	8										
	9										
	a										
	b										
	c										
	d										

CALCULATE θ

DISPLAY

CANTILEVER, TRIANGULAR LOAD



Reaction R ₂ and Vertical Shear V	Bending Moment M and Maximum Bending Moment	Deflection y, maximum deflection and end slope θ
$R_2 = +W$ $V = -W \left(\frac{2lx - x^2}{l^2} \right)$	$M = -\frac{1}{3} \frac{W}{l^2} (3lx^2 - x^3)$ Max M = $-\frac{2}{3} Wl$ at B	$y = -\frac{1}{60} \frac{W}{EI} l^2 (-x^5 - 15l^4x + 5lx^4 + 11l^5)$ Max y = $-\frac{11}{60} \frac{Wl^3}{EI}$ at A $\theta = +\frac{1}{4} \frac{W}{EI} l^2$ at A

$$\theta = \text{Radians} = \tan \theta$$

All forces are in pounds, all moments in inch-pounds, all deflections and dimensions in inches.

McGraw-Hill Book Company 1965

USER INSTRUCTIONS

EXAMPLES

ENTER PROGRAM (Starting Address is 0 - 0)

PRESS: GO TO (0) (0) [or END]

→ PRESS: CONTINUE

DISPLAY

0	—	Z
0	—	Y
1	—	X

ENTER DATA: W → Z, I → Y, x → X

PRESS: CONTINUE

DISPLAY

0	—	Z
0	—	Y
2	—	X

ENTER DATA: E → Y, I → X

PRESS: CONTINUE

DISPLAY

0	—	Z
R ₂	—	Y
V	—	X

PRESS: CONTINUE

DISPLAY

0	—	Z
M	—	Y
M _{MAX}	—	X

PRESS: CONTINUE

DISPLAY

Y	—	Z
Y _{MAX}	—	Y
θ	—	X

LET W = 1000

I = 100

x = 24

E = 10⁶

I = 20

THEN R₂ = 1000

V = -422.4

M = -5299.2

M_{MAX} = -66666.6

Y = -6.180

Y_{MAX} = -9.167

θ = .125

Step	Key	Code	Display			Storage					
			x	y	z	f	e	d	c	b	a
0	0	CLEAR	20								
1	1	01	DISPLAY 1 TO INDICATE FIRST ENTRY								
2	STOP	41	X	I	W	ENTER W, I, X					
3	ACC +	60									
4	CLEAR X	37									
5	ROLL ↓	31									
6	y→()	40									
7	d	17									
8	↓	25									
9	2	02	DISPLAY 2 TO INDICATE SECOND ENTRY								
a	STOP	41	I	E	O	ENTER E, I					
b	X	36									
c	d	17									
d	x↔y	30									
1	0	÷	35								
1	y→()	40									
2	C	16									
3	E	12									
4	↑	27									
5	2	02									
6	X	36									
7	f	15									
8	X	36									
9	↑	27									
a	X	36									
b	↓	25									
c	—	34									
d	E	12									
2	0	↑	27	CALCULATE R ₂ , V							
1	X	36									
2	↓	25									
3	÷	35									
4	d	17									
5	CHG SIGN	32									
6	X	36									
7	d	17									
8	x↔y	30									
9	↑	27									
a	CLEAR X	37									
b	ROLL ↓	31									
c	STOP	41	V	R ₂	O	DISPLAY					
d	E	12									

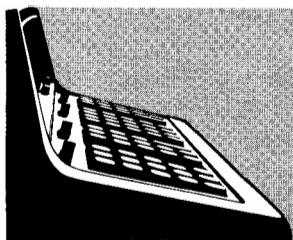
Computer
Museum

Step	Key	Code	Display			Storage					
			x	y	z	f	e	d	c	b	a
3	0	↑	27								
	1	3	03								
	2	X	36								
	3	F	15								
	4	X	36								
	5	X	36								
	6	↑	27								
	7	X	36								
	8	X	36								
	9	↓	25								
	a	—	34								
	b	d	17								
	c	X	36								
	d	3	03								
	4	0	÷	35	CALCULATE M, M _{MAX}						
1		E	12								
2		↑	27								
3		X	36								
4		↓	25								
5		CHG SIGN	32								
6		÷	35								
7		d	17								
8		↑	27								
9		E	12								
a		X	36								
b		2	02								
c		X	36								
d		3	03								
5		0	CHG SIGN	32							
	1	÷	35								
	2	CLEAR X	37								
	3	ROLL ↓	31								
	4	STOP	41	M _{MAX}	M	0	DISPLAY				
	5	F	15								
	6	↑	27								
	7	X	36								
	8	X	36								
	9	X	36								
	a	X	36								
	b	↑	27								
	c	1	01								
	d	5	05								

Step	Key	Code	Display			Storage					
			x	y	z	f	e	d	c	b	a
6	0	X	36								
	1	E	12								
	2	X	36								
	3	X	36								
	4	X	36								
	5	X	36								
	6	↓	25								
	7	+	33								
	8	y→()	40								
	9	b	14								
	a	f	15								
	b	↑	27								
	c	X	36								
	d	X	36								
7	0	X	36								
	1	E	12								
	2	X	36								
	3	5	05								
	4	X	36								
	5	E	12								
	6	↑	27								
	7	X	36								
	8	X	36								
	9	X	36								
	a	X	36								
	b	1	01								
	c	1	01								
	d	X	36								
8	0	↓	25								
	1	+	33								
	2	b	14								
	3	-	34								
	4	c	16								
	5	X	36								
	6	6	06								
	7	0	00								
	8	CHG SIGN	32								
	9	÷	35								
	a	E	12								
	b	÷	35								
	c	÷	35								
	d	y→()	40								

CALCULATE Y

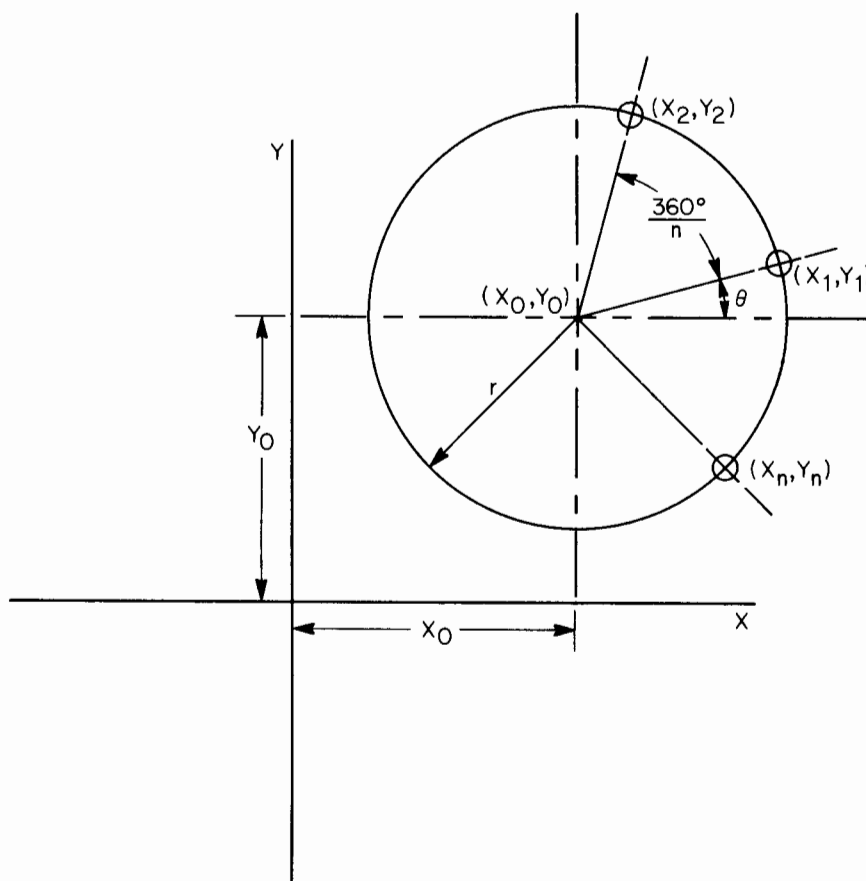
[illegible]



PART NO.
09100-74205

COORDINATES OF EQUALLY SPACED POINTS ON A CIRCLE

This program computes the coordinates (X_i, Y_i) $i = 1, \dots, n$ of equally spaced points on a circle of radius r . The user specifies the number of points n , and offset θ , and coordinates of the center of the circle X_0 and Y_0 . See the figure below.



The equations used are:

$$X_i = r \cos \left((i-1) \frac{360^\circ}{n} + \theta \right) + X_0$$

$i = 1, \dots, n$

$$Y_i = r \sin \left((i-1) \frac{360^\circ}{n} + \theta \right) + Y_0$$

θ - offset angle in degrees

USER INSTRUCTIONS

EXAMPLES

ENTER PROGRAM (Starting address is 0 - 0)

PRESS: GO TO (0) (0) [or END]

PRESS: CONTINUE

DISPLAY

0 — Z

0 — Y

1 — X

ENTER DATA: $Y_0 \rightarrow Y$, $X_0 \rightarrow X$

PRESS: CONTINUE

DISPLAY

0 — Z

0 — Y

2 — X

ENTER DATA: $\theta \rightarrow Z$, $n \rightarrow Y$, $r \rightarrow X$

PRESS: CONTINUE

DISPLAY

i — Z

Y_i — Y

X_i — X

PRESS CONTINUE AFTER i REACHES n TO
RESTART ANOTHER SOLUTION

$X_0 = 2$ in.

$Y_0 = 1$ in.

$r = 2$ in.

$n = 10$

$\theta = 0^\circ$

i	X_i	Y_i
1	3.618033989	2.175570505
2	2.618033989	2.902113033
3	1.381966011	2.902113033
4	0.381966011	2.175570505
5	0.000000000	1.000000000
6	0.381966011	-0.175570505
7	1.381966011	-.902113033
8	2.618033989	-.902113033
9	3.618033989	-.175570505
10	4.000000000	1.000000000

Step	Key	Code	Display			Storage					
			x	y	z	f	e	d	c	b	a
0	CLEAR	20									
1	1	01									
2	$x \rightarrow ()$	23									
3	9	11									
4	STOP	41	X_0	Y_0	0						
5	$x \rightarrow ()$	23									
6	d	17									
7	$y \rightarrow ()$	40									
8	C	16									
9	CLEAR	20									
a	2	02									
b	STOP	41	r	n	θ^0						
c	ACC +	60									
d	ROLL $\uparrow$	22									
1	$x \rightarrow ()$	23									
1	b	14									
2	3	03									
3	6	06									
4	0	00									
5	ROLL $\uparrow$	22									
6	$\div$	35									
7	$y \rightarrow ()$	40									
8	a	13									
9	b	14									
a	+	33									
b	$y \rightarrow ()$	40									
c	b	14									
d	1	01									
2	TO RECT	66									
1	$\uparrow$	27									
2	F	15									
3	X	36									
4	ROLL $\uparrow$	22									
5	X	36									
6	C	16									
7	+	33									
8	d	17									
9	ROLL $\uparrow$	22									
a	+	33									
b	ROLL $\uparrow$	22									
c	$y \rightarrow ()$	24									
d	9	11									

FROM 4-1

DISPLAY 1 TO INDICATE FIRST ENTRY
AND INITIALIZE COUNTERENTER Y_0, X_0

STORE DATA

DISPLAY 2 TO INDICATE SECOND ENTRY

ENTER θ^0, n, r

STORE DATA

CALCULATE $\Delta\theta$ CALCULATE θ_1 STORE θ_i

FROM 4-5

CALCULATE X_i AND Y_i

[illegible]