

HAAS AUTOMATION, INC.
MILL SERIES
PROGRAMMING



WORKBOOK

ANSWERS

HAAS AUTOMATION, INC.
2800 STURGIS ROAD
OXNARD, CA 93030
www.HaasCNC.com
800-331-6746

**HAAS AUTOMATION INC.**

2800 Sturgis Road
Oxnard, California 93030
Phone: 805-278-1800
www.HaasCNC.com

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POSITIONING EXERCISE (PAGE #8)

What is the value in X and Y for each hole in absolute G90 positioning when each move is defined from a single fixed part zero point of an X0 Y0 origin point.

PT1	=	<u>X3</u>	<u>Y3</u>
PT2	=	<u>X3</u>	<u>Y-3</u>
PT3	=	<u>X-3</u>	<u>Y-3</u>
PT4	=	<u>X-3</u>	<u>Y3</u>
PT5	=	<u>X6</u>	<u>Y7</u>
PT6	=	<u>X9</u>	<u>Y7</u>
PT7	=	<u>X9</u>	<u>Y-5</u>
PT8	=	<u>X6</u>	<u>Y-5</u>

What is the value for each hole in INCREMENTAL G91 positioning when each move is defined from the previous position and the zero point shifts with the new position.

From	PT8	to	PT9	=	<u>X-12</u>	<u>Y-1</u>
From	PT9	to	PT10	=	<u>X-1</u>	<u>Y12</u>
From	PT10	to	PT11	=	<u>X4</u>	<u>Y0</u>
From	PT11	to	PT12	=	<u>X2</u>	<u>Y-1</u>
From	PT12	to	PT13	=	<u>X2</u>	<u>Y1</u>
From	PT13	to	PT14	=	<u>X2</u>	<u>Y-1</u>

INTERPOLATION EXERCISE (PAGE #41)

O00010 (INTERPOLATION EXERCISE)

T1 M06 (1/2 DIA. 4FLT. END MILL)

G90 G54 G00 X-0.25 Y0.25

S1520 M03

G43 H01 Z0.1 M08

G01 Z-0.625 F50.

X3.5 F12. (Feed end mill over to the top right radius and continue around part, to the end, defining center of tool. Cutter compensation is not being used here.)

G02 X4.25 Y-0.5 R0.75 (or use **I0. J-0.75** instead of **R**)

G01 Y-3.5

G02 X3.5 Y-4.25 R0.75 (or use **I-0.75 J0.** instead of **R**)

G01 X0.25

Y-4.

G03 X0. Y-3.75 R0.25 (or use **I-0.25 J0.** instead of **R**)

G01 X-0.25

Y0.25

G00 Z1. M09

G28 G91 Z0. M05

M30

CIRCULAR POCKET MILLING EXERCISE (PAGE #55)

O00020 (CIRCULAR POCKET MILLING EXERCISE)

T2 M06 (5/8 DIA. 2FLT. CENTER CUTTING END MILL)

G90 G54 G00 X1.25 Y-1.25 (X Y position to center of CPM1)

S1620 M03

G43 H02 Z0.1 M08 (Rapid to .1 above part)

G13 Z-0.5 I0.25 K0.99 Q0.2 D02 F7.2 (do CPM1 using I,K & Q)

G13 I1. D02 F12.5 (do a finish pass on CPM1 using I only)

G00 Z0.1 (Z rapid to clearance position above part)

X2.75 Y-2.75 (X Y position to center of CPM2)

G01 Z0. F20. (feed down to the start point to start incremental depth down)

G13 G91 Z-0.25 I0.3 K1. Q0.35 D02 L3 F10. (CPM2 with I,K & Q and G91)

G90 G00 Z1. M09 (rapid 1.0 above part, coolant off)

G53 G49 Z0. M05

M30

CUTTER COMPENSATION EXERCISE #1 (PAGE #66)

O00030 (CUTTER COMPENSATION EXERCISE #1)

T1 M06 (1/2 DIA. 4 FLT. END MILL)

G90 G54 G00 X-0.25 Y0.35

S2400 M03

G43 H01 Z0.1 M08 (Rapid to .1 above part)

G01 Z-0.625 F50. (Fast feed to depth non-cutting move)

G41 X0. D01 F12. (Turning on cutter compensation)

X3.5

G02 X4. Y-0.5 R0.5 (or use I0. J-0.5 instead of R)

G01 Y-3.5

G02 X3.5 Y-4. R0.5 (or use I-0.5 J0. instead of R)

G01 X0.5

G03 X0. Y-3.5 R0.5 (or use I-0.5 J-0. instead of R)

G01 Y0.25 (Position off part at least half the cutter diameter before canceling C.C.)

G40 G01 X-0.25 Y0.35 (Cancel cutter compensation feeding off of part)

G00 Z1. M09

G53 G49 Z0. M05

M30

CUTTER COMPENSATION EXERCISE #2 (PAGE #69)

O00040 (CUTTER COMPENSATION EXERCISE #2)

T12 M06 (3/4 DIA. 4FLT. END MILL)

G90 G54 G00 X-0.475 Y-0.375

S1120 M03

G43 H12 Z0.1 M08

G01 Z-0.45 F50.

G41 X0. D12 F11.2 (Turn on cutter compensation moving onto part)

Y3.5

G02 X0.5 Y4. R0.5

G01 X6.

G03 X7. Y5. R1.

G01 Y7.25

G02 X8. Y7.25 R0.5

G01 Y0.

G01 X5.

G03 X3. Y0. R1.

G01 X-0.375 (Position off part at least half cutter diameter before canceling C.C.)

G40 X-0.475 Y-0.375 (Cancel cutter compensation moving off of part)

G00 Z1. M09

G53 G49 Z0. M05

M30

CANNED CYCLE EXERCISE #1 (PAGE #81)

O00050 (CANNED CYCLE EXERCISE #1)

T3 M06 (1/2 DIA. SPOT DRILL)

G90 G54 G00 X3. Y-0.375

S1604 M03

G43 H03 Z1. M08

G81 G99 Z-0.2 R0.1 F6.4

X3.625 Y-1.

X1.5 Y-3.5

X0.5 Y-2.5

G80 G00 Z1. M09

G53 G49 Z0. M05

M01

T4 M06 (1/4 DIA. DRILL)

G90 G54 G00 X3. Y-0.375

S3209 M03

G43 H04 Z1. M08

G83 G99 Z-1.1 Q0.15 R0.1 F16.

X3.625 Y-1.

X1.5 Y-3.5

X0.5 Y-2.5

G80 G00 Z1. M09

G53 G49 Z0. M05

M01

T5 M06 (3/8 DIA. 4 FLT E.M.)

G90 G54 G00 X3. Y-.375

S2139 M03

G43 H05 Z1. M08

G82 G99 Z-.325 P0.2 R0.1 F12.8

X3.625 Y-1.

X1.5 Y-3.5

X0.5 Y-2.5

G80 G00 Z1. M09

G53 G49 Y0. Z0. M05

M30

CANNED CYCLE EXERCISE #2 (PAGE #91)

O00060 (CANNED CYCLE EXERCISE #2)

T1 M06 (90 Deg. 1/2 DIA. SPOT DRILL)

G90 G54 G00 X0.5 Y0.375

S1681 M03

G43 H01 Z1. M08

G81 G99 Z-0.2 R0.1 F8.4

Y-1.125

Y-1.875

Y-2.625

X1.5

Y-1.875

Y-1.125

G98 Y-0.375

G99 X3.5 Z-0.45 R-0.15

Y-1.125

Y-1.875

Y-2.625

X4.5 Z-.7 R-.4

Y-1.875

Y-1.125

Y-0.375

G80 G00 Z1. M09

G53 G49 Z0. M05

T2 M06 ("U" .368 DIA. DRILL)

G90 G54 G00 X0.5 Y0.375

S2284 M03

G43 H02 Z1. M08

G83 G99 Z-1.14 Q0.2 R0.1 F16.

Y-1.125

Y-1.875

Y-2.625

X1.5

Y-1.875

Y-1.125

G98 Y-0.375

G99 X3.5 R-0.15

Y-1.125

(continued)

Y-1.875
Y-2.625
X4.5 R-0.4
Y-1.875
Y-1.125
Y-0.375
G80 G00 Z1. M09
G53 G49 Z0. M05

T3 M06 (7/16-14 TAP)
G90 G54 G00 X0.5 Y0.875
S525 M03
G43 H03 Z1. M08
G84 G99 Z-1.2 R0.1 F37.5
Y-1.125
Y-1.875
Y-2.625
X1.5
Y-1.875
Y-1.125
G98 Y-0.375
G99 X3.5 R-0.15
Y-1.125
Y-1.875
Y-2.625
X4.5 R-0.4
Y-1.875
Y-1.125
Y-0.375
G80 G00 Z1. M09
G53 G49 Y0. Z0. M05
M30

CANNED CYCLE EXERCISE #3 (PAGE #103)

O00070 (CANNED CYCLE EXERCISE #3)

T06 M06 (#7 .201 DIA. CARBIDE STUB DRILL)

G90 G54 G00 X1.25 Y-1.25 (X Y Position to center of bolt circle)

S3200 M03

G43 H06 Z1. M08 (Position to Z.1 for the initial point, coolant on)

G83 G98 Z-0.95 Q0.2 R-0.4 F11.5 (G83 with G98 initial point return)

G70 I0.7 J10. L6 (Bolt hole circle command 6 holes)

X2.75 Y-2.75 L0 (BOLT HOLE ARC center, but no hole here using L0)

G71 Z-1.1 R-0.65 I0.7 J0. K-30. L5 (Bolt hole ARC command 5 holes)

G72 X2.5 Y-0.5 Z-0.65 R0.1 I0.5 J-45. L4 (Define XY location, the new Z depth and change the R plane for the Bolt Holes Along an Angle)

G80 G00 Z1. M09 (Cancel canned cycle and turn off coolant)

G53 G49 Z0. M05 (Send Y and Z home and turn off spindle)

T07 M06 (#1/4-20 SPIRAL TAP)

G90 G54 G00 X1.25 Y-1.25 (X Y Position to center of bolt circle)

S750 M03

G43 H07 Z.1 M08 (Position to Z.1 for the initial point, coolant on)

G84 G98 Z-0.8 R-0.4 F37.5 (G84 with G98 initial point return)

G70 I0.7 J10. L6 (Bolt hole circle command 6 holes)

X2.75 Y-2.75 L0 (BOLT HOLE ARC center, but no hole here using L0)

G71 Z-1.1 R-0.65 I0.7 J0. K-30. L5 (Bolt hole ARC command 5 holes)

G72 X2.5 Y-0.5 Z-0.55 R0.1 I0.5 J-45. L4 (Define XY location, the new Z depth and change the R plane for the Bolt Holes Along an Angle)

G80 G00 Z1. M09 (Cancel canned cycle and turn off coolant)

G28 G91 Y0. Z0. M05 (Send Y and Z home and turn off spindle)

M30 (End of Program)

FINAL EXERCISE (PAGE #132)

O00080 (FINAL EXERCISE)
T1 M06 (3/4 .750 DIA. 4 FLT. END MILL)
G90 G54 G00 X-2.5 Y2.05
S1273 M03
G43 H01 Z1. M08
G01 Z-0.3 F50.
G41 Y1. D01 F15.2
X1.5
G02 X1.75 Y0.75 R0.25
G01 Y0.15
X0.4 Y-1.2
X-0.4
X-1.75 Y0.15
Y0.75
G02 X-1.5 Y1. R0.25
G40 G01 X-1.5 Y2.05
G00 Z1. M09
G53 G49 Z0. M05

T2 M06 (7/8 .875 DIA. 2 FLT. INSERT DRILL)
G90 G54 G00 X0. Y0.
S1091 M03
G43 H02 Z1. M08
G81 G99 Z-0.48 R0.1 F10.9
G80 G00 Z1. M09
G53 G49 Z0. M05

T3 M06 (5/8 .625 DIA. 2 FLT. END MILL)
G90 G54 G00 X0. Y0.
S1528 M03
G43 H03 Z0.1 M08
G13 Z-0.5 I0.25 K0.9 Q0.3 D03 F7.6
G00 Z1. M09
G53 G49 Z0. M05

(continued on next page)

T4 M06 (1/2 DIA. SPOT DRILL)
G90 G54 G00 X-1.5 Y1.25
S1604 M03
G43 H04 Z0.1 M08
G81 G99 Z-0.4 R-0.2 F9.6
M98 P81

T5 M06 (5/16 DIA. DRILL)
G90 G54 G00 X-1.5 Y1.25
S2567 M03
G43 H05 Z0.1 M08
G83 G99 Z-.72 Q0.1 R-0.2 F12.12
M98 P81

T6 M06 (3/8-16 TAP)
G90 G54 G00 X-1.5 Y1.25
S650
G43 H06 Z0.1 M08
G84 G99 Z-0.75 R-0.2 F40.625
M98 P81
G53 Y0.
T1 M06
M30

FINAL EXERCISE SUB-PROGRAM
(PAGE #137)

(SUB-PROGRAM)

O00081(A SEPARATE PROGRAM)

G98 X1.5

G99 Y-0.5

G98 X0.75 Y-1.25

G99 X-0.75

X-1.5 Y-0.5

G80 G00 Z0.1 M09

G53 G49 Z0. M05

M99