Contents: Basic Course G426 ISO Programming

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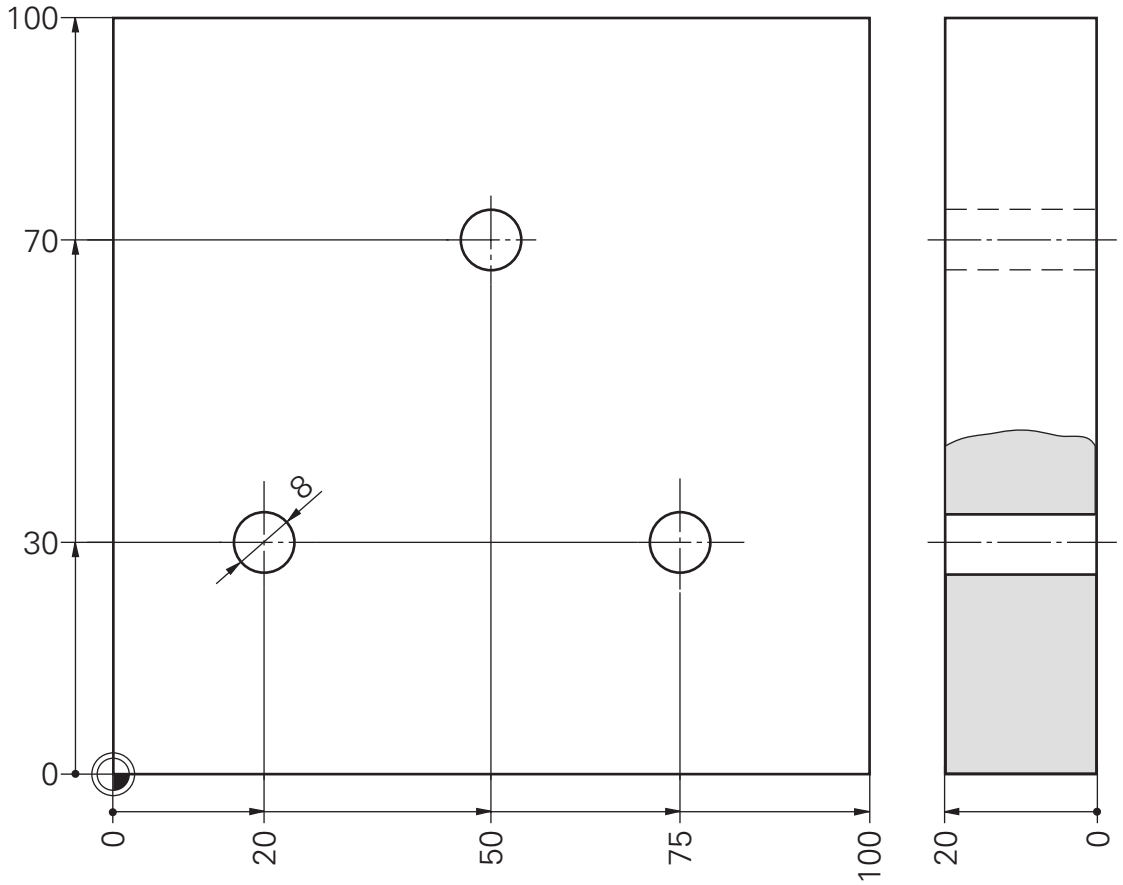
Task: **Holes**

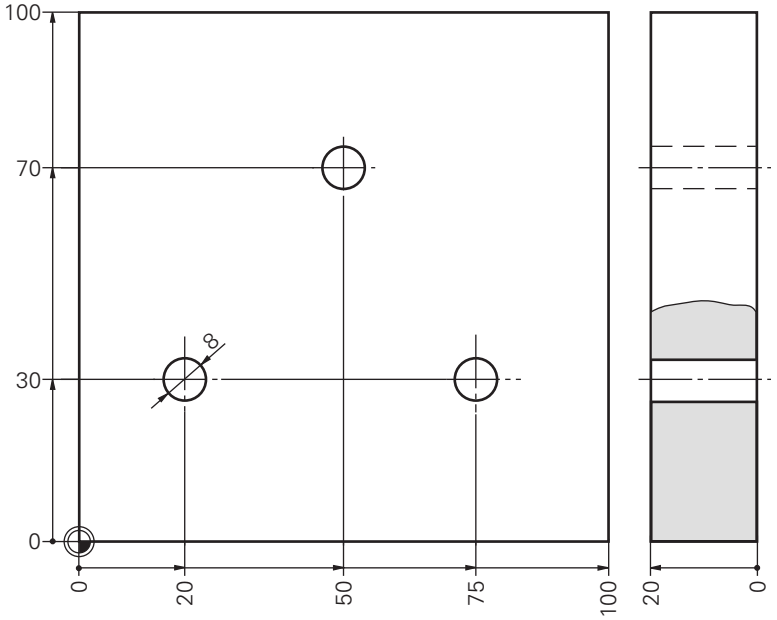
Program(s): _____



Program layout: **Holes**

Operating mode "Programming"		
Begin program	PGM MGT	*%62151 G71*
Define workpiece blank		*G30 ... X... Y... Z...* *G31 ... X... Y... Z...*
Define tool		*G99 T... L... R...*
Activate tool		*T... G... S...*
Move to clearance height		*G00 G40 G90 Z+100 M3*
Move to starting point		*X... Y...*
Move to setup clearance		*Z+... M8*
Drill		*G01 Z–... F400*
Retract drill		*G00 Z+2*
Next hole		*X... Y...*
Drill		*G01 Z–...*
Retract drill		*G00 Z+...*
Next hole		*X... Y...*
Drill		*G01 Z–...*
Return to clearance height End of program		*G00 Z+100 M2 (M30)*

Solution: **Holes**

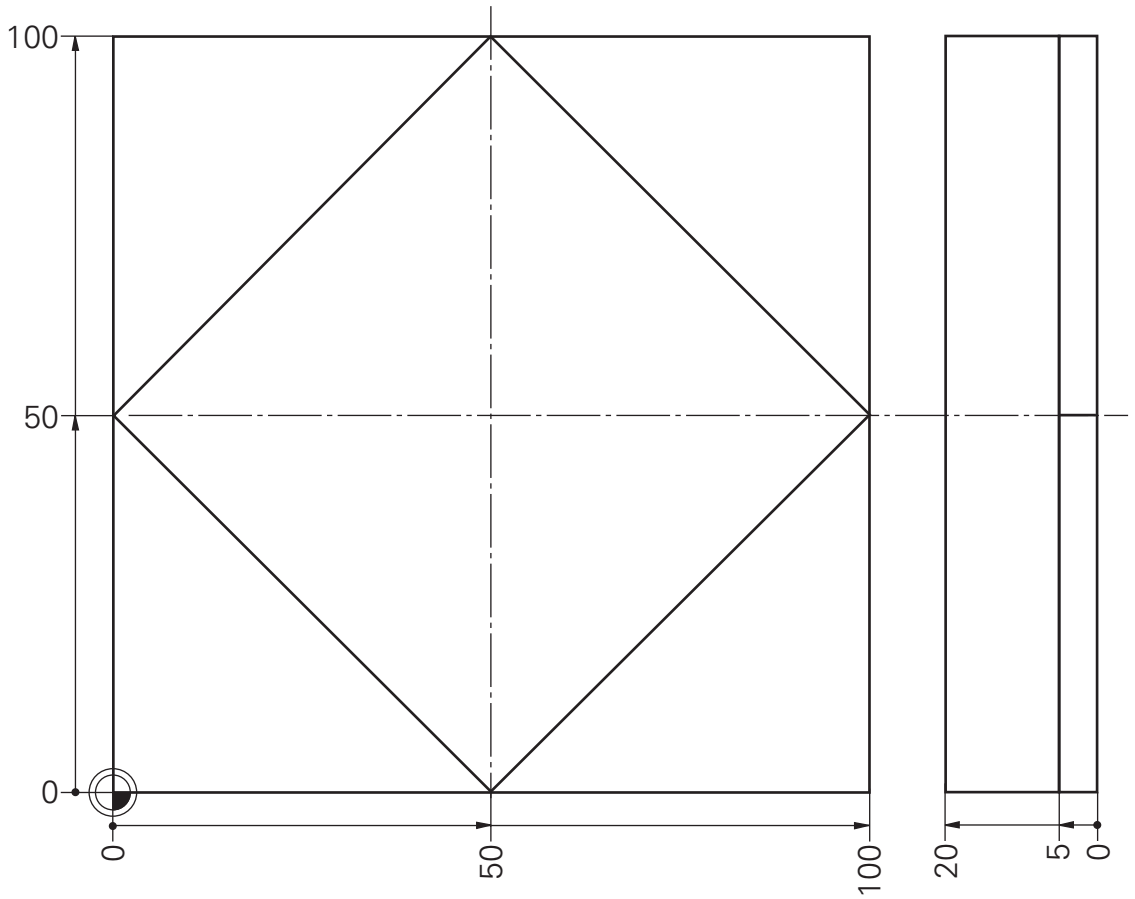


Complete program

```
%62151 G71 *
N10  G30 G17 X+0 Y+0 Z-20 *
N20  G31 G90 X+100 Y+100 Z+0 * ..... WORKPIECE BLANK DEFINITIONS
N30  G99 T1 L+0 R+4 * ..... TOOL DEFINTION
N40  T1 G17 S4000 * ..... TOOL CALL
N50  G00 G90 Z+100 M03 * ..... CLEARANCE HEIGHT
N60  X+20 Y+30 * ..... 1ST HOLE
N70  Z+2 M08 *
N80  G01 Z-22 F400 * ..... DRILL
N90  G00 Z+2 *
N100  X+50 Y+70 * ..... 2ND HOLE
N110  G01 Z-22 *
N120  G00 Z+2 *
N130  X+75 Y+30 * ..... 3RD HOLE
N140  G01 Z-22 *
N150  G00 Z+100 M30 *
N999999 %62151 G71 *
```

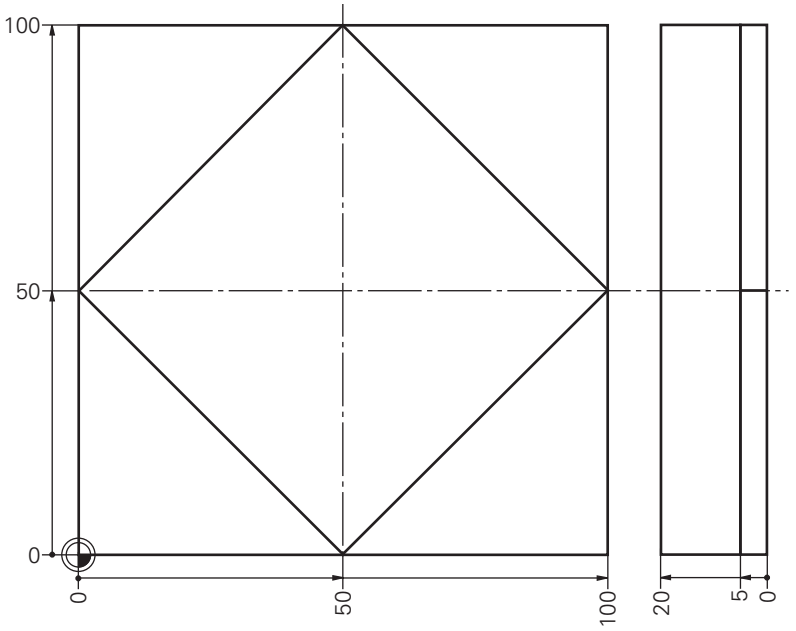
Task: **Square**

Program(s): _____



Create program	*%62152 G71*
Define workpiece blank	*G30 G... X... Y... Z...*
	G31 G... X... Y... Z...
Define tool	*G99 T... L... R...*
Activate tool	*T... G... S...*
Move to clearance height	*G00 G40 G90 Z+...*
Move to auxiliary point G40	*X... Y...*
Plunging depth	*Z–...*
Contour starting point G41/G42	*G01 G41 X... Y...*
Contour coordinates G41/G42	*X... Y...*
⋮	⋮
Last contour point G41/G42	*X... Y...*
Move to auxiliary point G40	*G40 X... Y...*
Retract tool, PGM end	*G00 Z+... M2/M30*

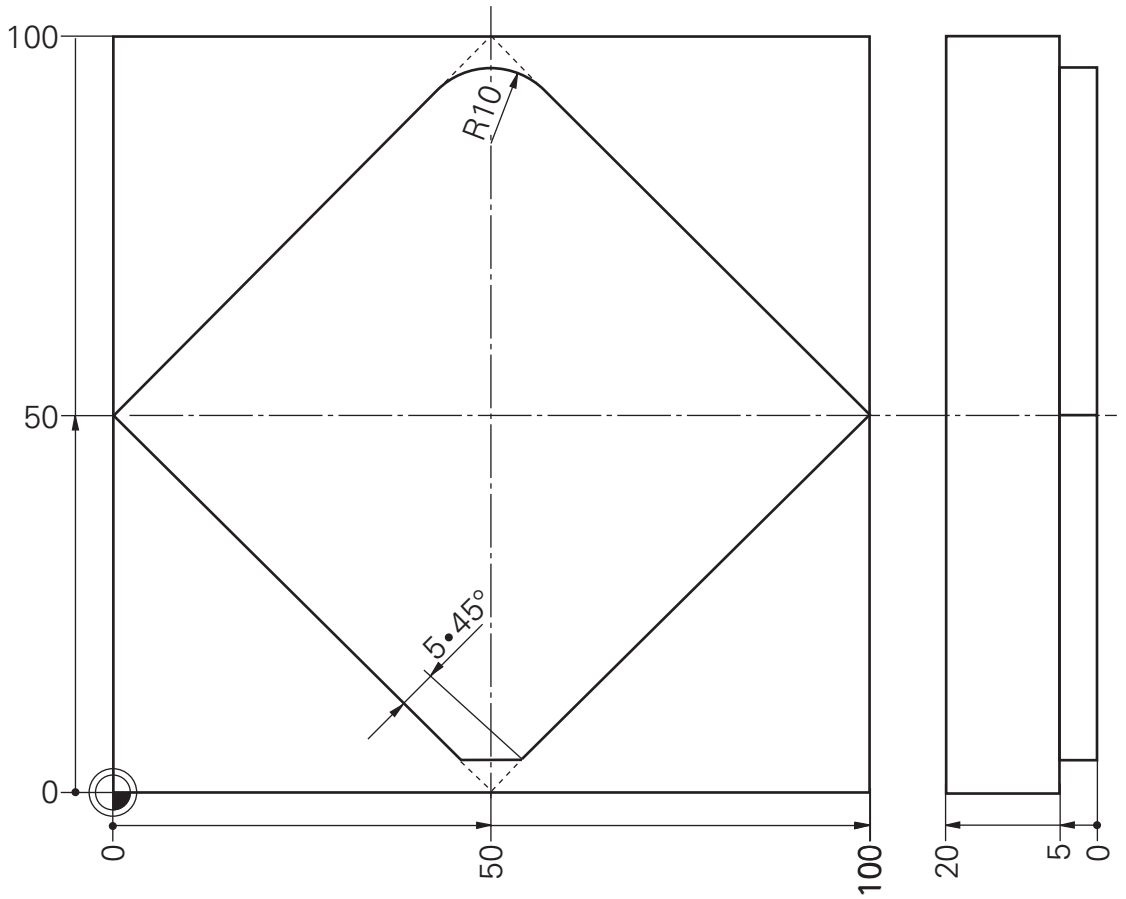
Solution: **Square**



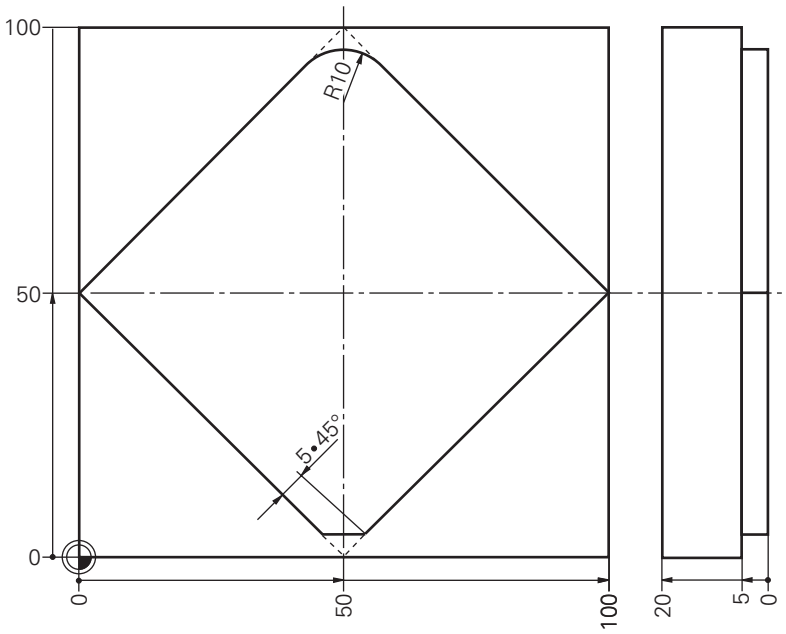
Complete program

```
%62152 G71 *
N10  G30 G17 X+0 Y+0 Z-20 *
N20  G31 G90 X+100 Y+100 Z+0 * ..... WORKPIECE BLANK DEFINITIONS
N30  G99 T1 L+0 R+8 * ..... TOOL DEFINITION
N40  T1 G17 S4000 * ..... TOOL CALL
N50  G00 G40 G90 Z+100 M03 * ..... CLEARANCE HEIGHT
N60  X-30 Y+50 * ..... AUXILIARY POINT (G40)
N70  Z-5 * ..... PLUNGING DEPTH
N80  G01 G41 X+0 Y+50 F400 * ..... CONTOUR STARTING POINT
N90  X+50 Y+100 *
N100 X+100 Y+50 *
N110 X+50 Y+0 *
N120 X+0 Y+50 * ..... LAST CONTOUR POINT
N130 G40 X-30 Y+50 * ..... AUXILIARY POINT
N140 G00 Z+100 M30 * ..... RETRACT TOOL / PGM END
N999999 %62152 G71 *
```

Task: **Rounding / chamfering corners** Program(s): _____



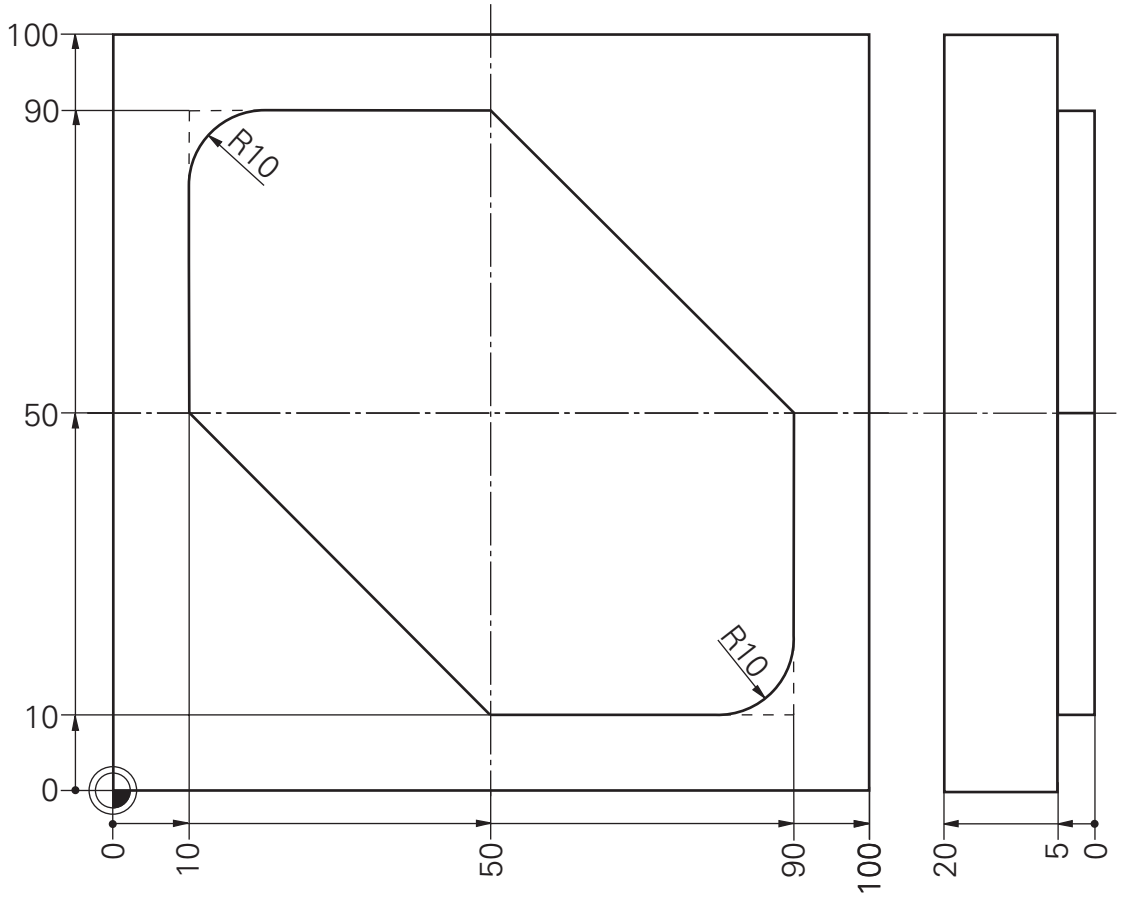
Solution: **Rounding / chamfering corners**



Complete program

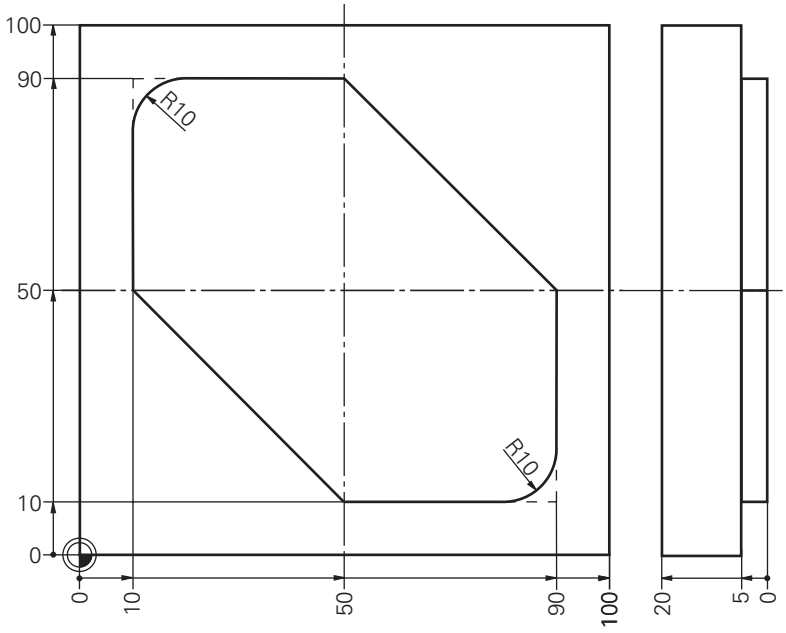
```
%62153 G71 *
N10  G30 G17 X+0 Y+0 Z-20 *
N20  G31 G90 X+100 Y+100 Z+0 * ..... WORKPIECE BLANK DEFINITION
N30  G99 T1 L+0 R+8 * ..... TOOL DEFINITION
N40  T1 G17 S4000 * ..... TOOL CALL
N50  G00 G40 G90 Z+100 M03 * ..... CLEARANCE HEIGHT
N60  X-30 Y+50 * ..... AUXILIARY POINT (G40)
N70  Z-5 *
N80  G01 G41 X+0 Y+50 F400 * ..... CONTOUR STARTING POINT
N90  X+50 Y+100 *
N100 G25 R10 F200 * ..... ROUND CORNER
N110 X+100 Y+50 *
N120 X+50 Y+0 *
N130 G24 R5 * ..... CHAMFER
N140 X+0 Y+50 *
N150 G40 X-30 Y+50 * ..... AUXILIARY POINT (G40)
N160 G00 Z+100 M30 * ..... PGM END
N999999 %62153 G71 *
```

Task: **Contour approach / departure** Program(s): _____



Begin program	*%62154 G71*
Define workpiece blank	*G30 G... X... Y... Z...* *G31 G... X... Y... Z...*
Define tool	*G99 T... L... R...*
Activate tool	*T... G... S...*
Move to clearance height	*G00 G40 G90 Z+...*
Move to auxiliary point	*X... Y...*
Plunging depth	*Z–...*
First contour point	*G01 G41 X... Y... F...*
Smooth approach	*G26 R...*
Contour	*X... Y...*
⋮	⋮
Smooth departure	*G27 R...*
Auxiliary point	*G40 X... Y...*
Retract tool, PGM end	*G00 Z+... M2/M30*

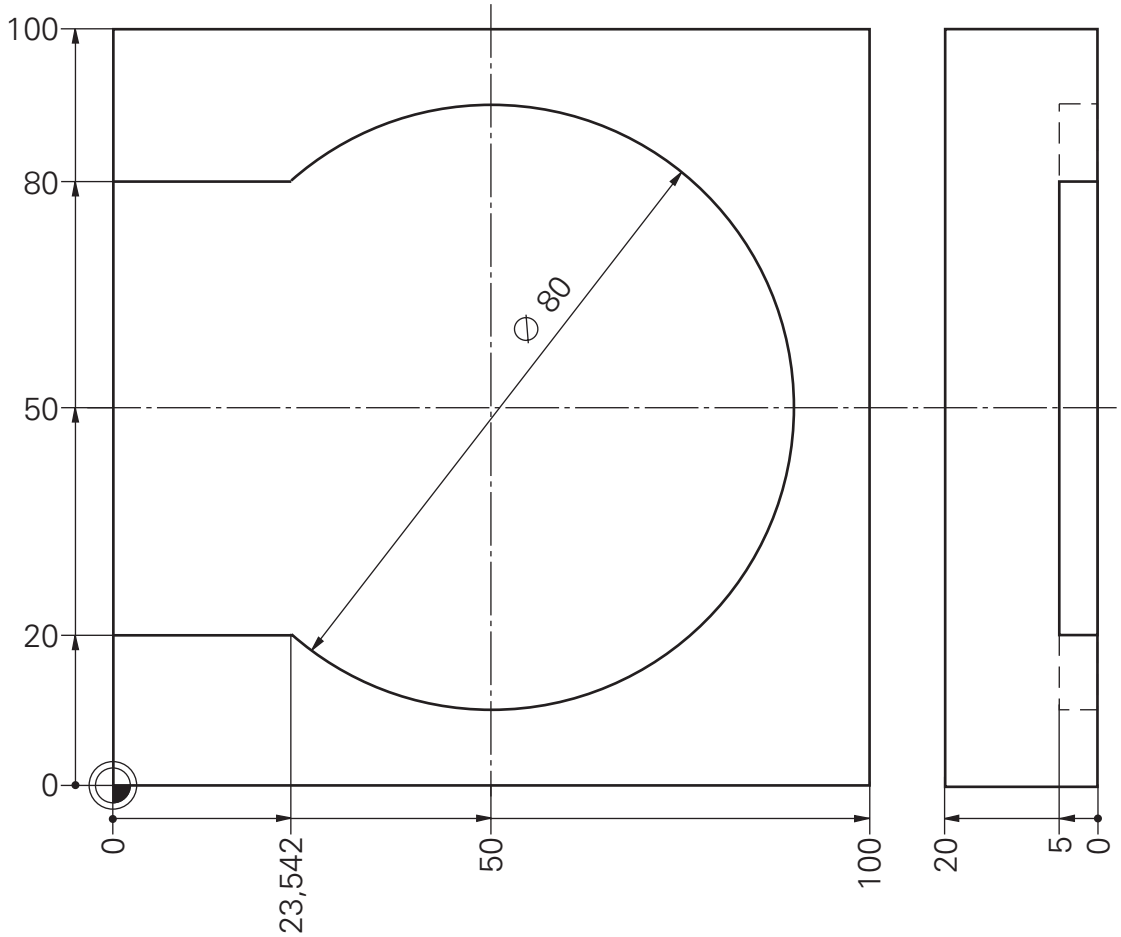
Solution: **Contour approach / departure**



Complete program

```
%62154 G71 *
N10  G30 G17 X+0 Y+0 Z-20 *
N20  G31 G90 X+100 Y+100 Z+0 *
N30  G99 T1 L+0 R+8 *
N40  T1 G17 S4000 *
N50  G00 G40 G90 Z+100 M03 *
N60  X-30 Y+70 * ..... AUXILIARY POINT (G40)
N70  Z-5 *
N80  G01 G41 X+10 Y+70 F400 * ..... STARTING POINT
N80  G26 R3 * ..... SMOOTH APPROCH TO
                    STARTING POINT
N90  Y+90 *
N100 G25 R10 *
N110 X+50 *
N120 X+90 Y+50 *
N130 Y+10 *
N140 G25 R10 *
N150 X+50 *
N160 X+10 Y+50 *
N170 Y+70 * ..... LAST CONTOUR POINT G41
N180 G27 R3 * ..... SMOOTH DEPARTURE TO
                    AUXILIARY POINT
N190 G40 X-30 Y+70 * ..... AUXILIARY POINT
N200 G00 Z+100 M30 *
N999999 %62154 G71 *
```

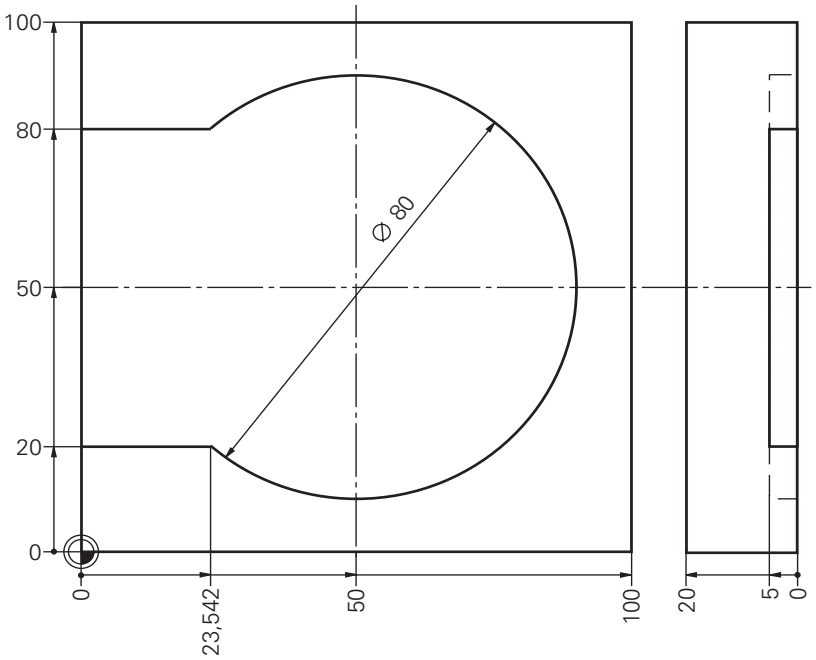
Task: **Circular arc with CC, C** Program(s): _____



Begin program	*%62155 G71*
Define workpiece blank	*G30 G . . . X . . . Y . . . Z . . .* *G31 G . . . X . . . Y . . . Z . . .*
Activate tool	*T . . . G . . . S . . .*
Move to clearance height	*G00 . . .*
Move to auxiliary point R0	
Plunging depth	
Approach contour	*G01 G . . .*
Define circle center	*I . . . J . . .*
Circular movement	*G02/G03 . . .*
Depart (aux. point)	*G01 . . .*
Retract tool, PGM end	*G00 . . .*

Solution:

Circular arc with CC, C

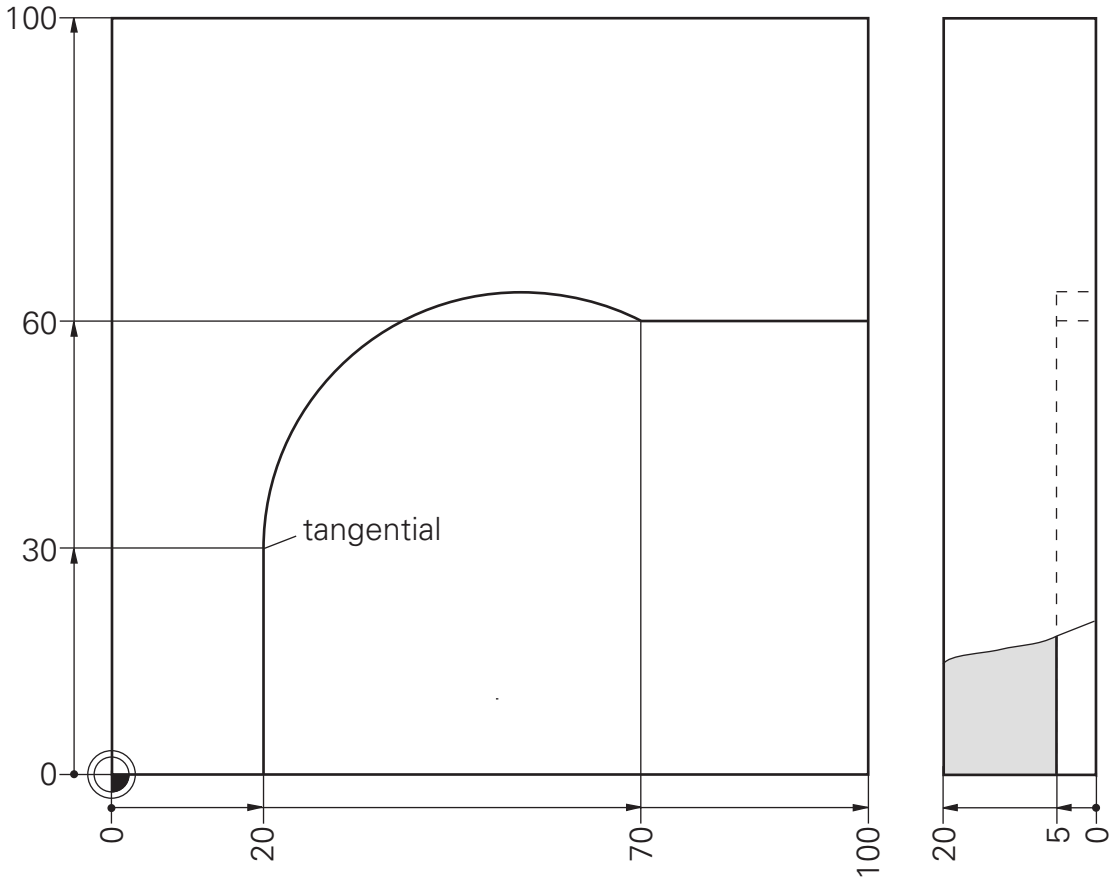


Complete program

```
%62155 G71 *
N5   G30 G17 X+0 Y+0 Z-20 *
N10  G31 G90 X+100 Y+100 Z+0 *
N15  T3 G17 S2500 * ..... R20
N20  G00 G40 G90 Z+100 M03 *
N25  X-30 Y+50* ..... AUXILIARY POINT
N30  Z-5 *
N35  G01 G41 X-5 Y+20 F250 *
N40  X+23,542 Y+20 *
N45  I+50 J+50* ..... CIRCLE CENTER
N50  G03 X+23,542 Y+80* ..... CIRCULAR MOVEMENT
N55  G01 X-5 *
N60  G40 X-30 Y+50 *
N65  G00 Z+100 M30 *
N999999 %62155 G71 *
```

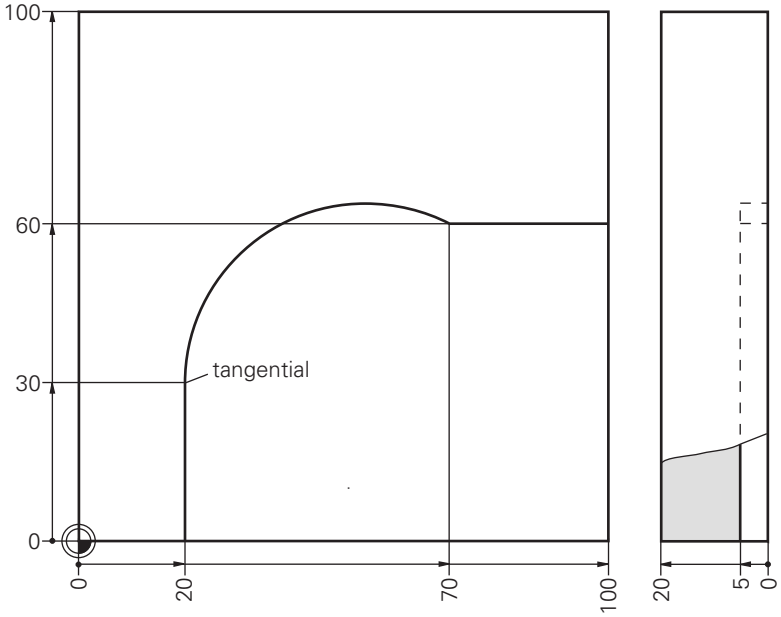
Task: **Tangential contour connection (cartesian)**

Program(s): _____



Solution:

Tangential contour connection (cartesian)

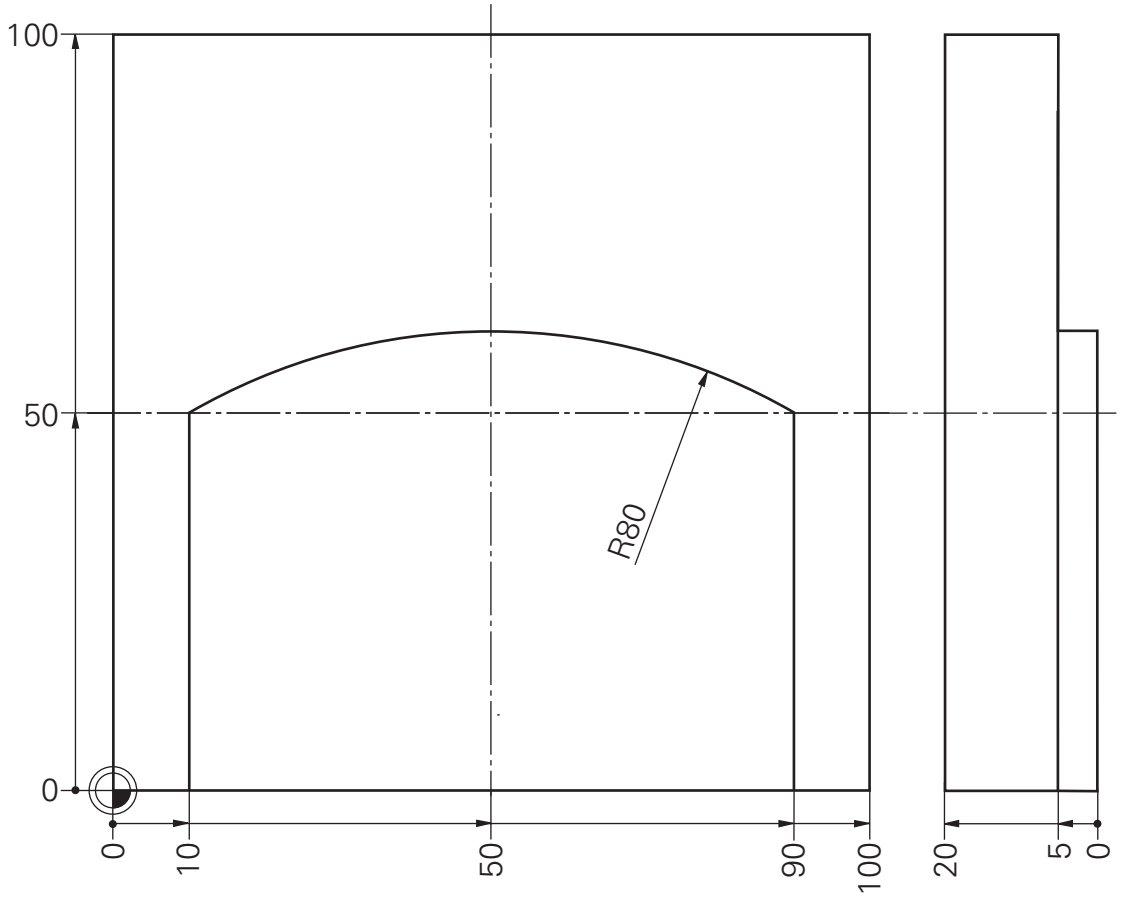


Complete program

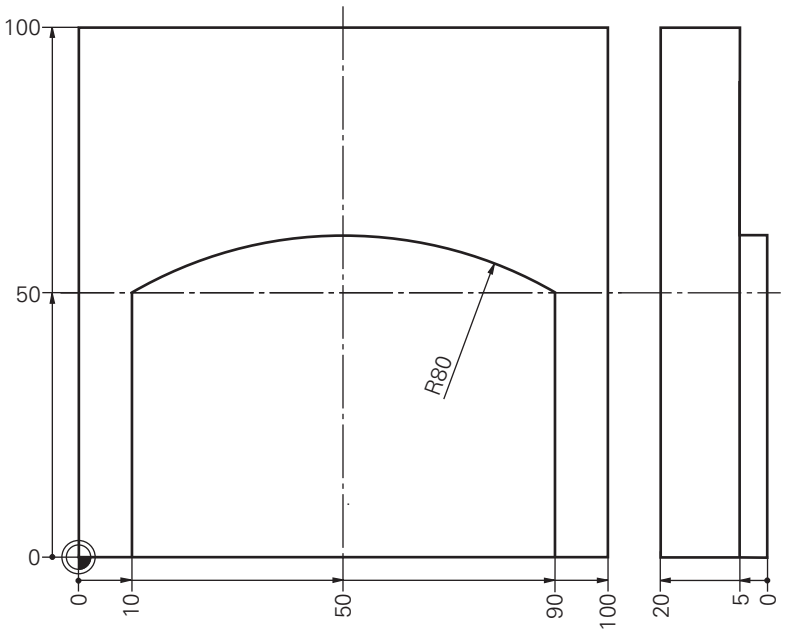
```
%62156 G71 *
N5    G30 G17 X+0 Y+0 Z-20 *
N10   G31 G90 X+100 Y+100 Z+0 *
N15   T11 G17 S2500 * ..... R10
N20   G00 G40 G90 Z+100 M03 * ..... CLEARANCE HEIGHT
N25   X+45 Y-25 * ..... AUXILIARY POINT
N30   Z-5 *
N35   G01 G42 X+20 Y-3 F250 * ..... CONTOUR STARTING POINT
N40   Y+30 *
N45   G06 X+70 Y+60 * ..... TANGENTIAL CIRCULAR PATH
N50   G01 X+103 *
N55   G40 X+110 Y+50 F500 *
N60   G00 Z+100 M30 *
N999999 %62156 G71 *
```

Task: **Circular arc with CR**

Program(s): _____



Solution: **Circular arc with CR**

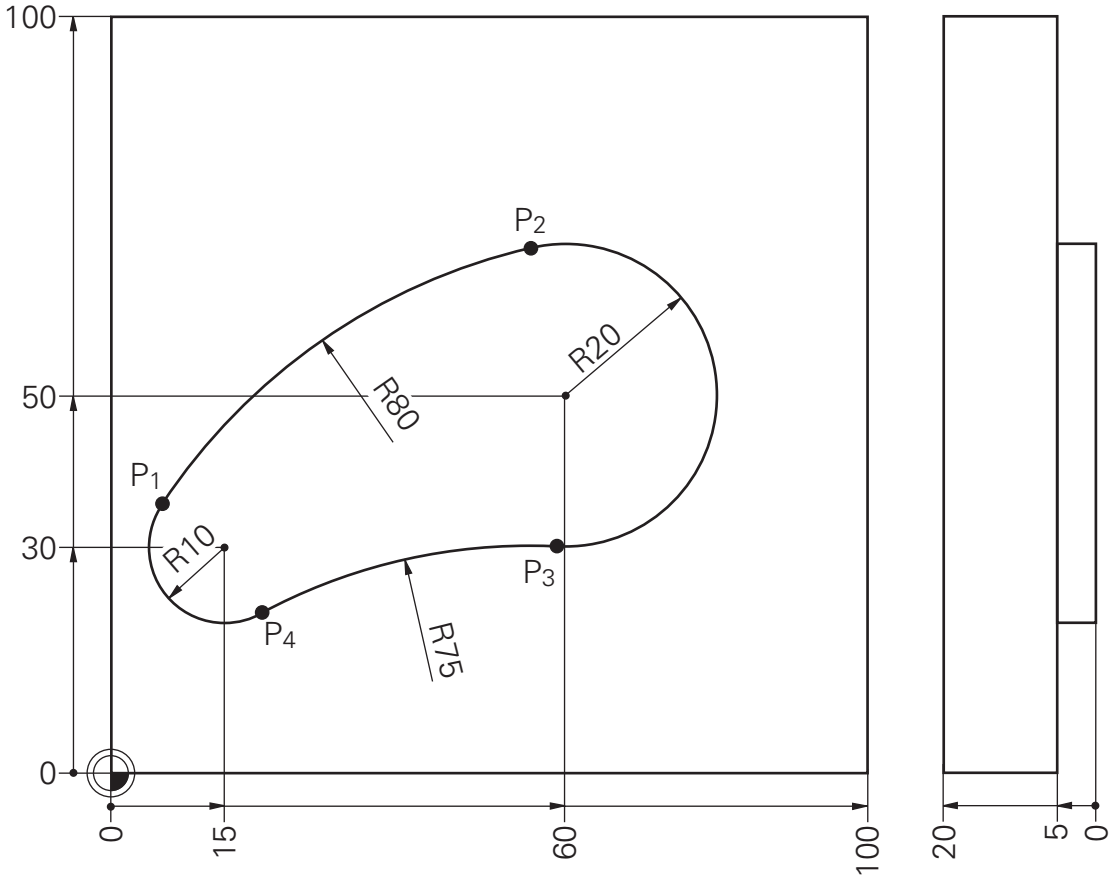


Complete program

```
%62157 G71 *
N5    G30 G17 X+0 Y+0 Z-20 *
N10   G31 G90 X+100 Y+100 Z+0 *
N15   T13 G17 S2500 * ..... R20
N20   G00 G40 G90 Z+100 M03 *
N25   X-30 Y-30* ..... AUXILIARY POINT
N30   Z-5 *
N35   G01 G41 X+10 Y-3 F250* ..... APPROACH STARTING POINT
N40   Y+50*
N45   G02 X+90 Y+50 R+80* ..... CIRCULAR ARC
N50   G01 Y-3 *
N55   G40 X+110 Y-30 F500* ..... DEPART (AUXILIARY POINT)
N60   G00 Z+100 M30*
N999999 %62157 G71 *
```

Task: **Circular arcs**

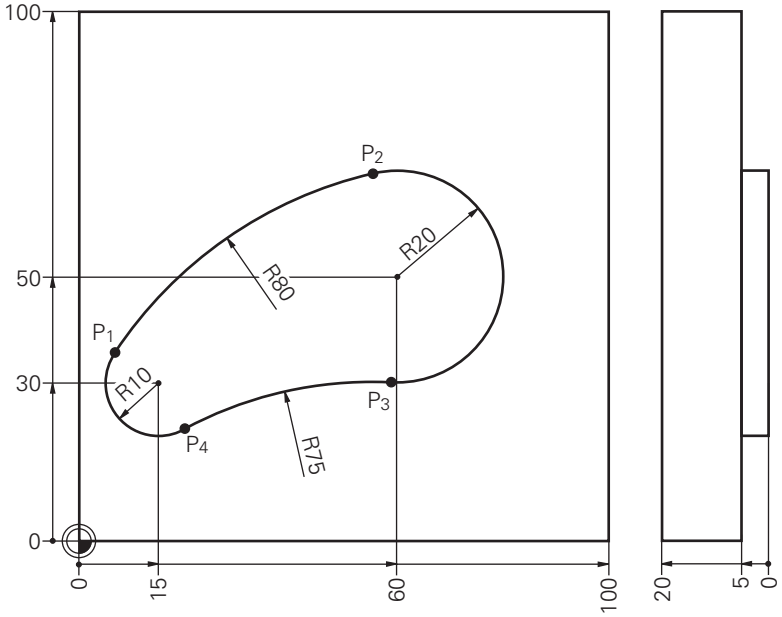
Program(s): _____



Point	X	Y
P_1	6.645	35.495
P_2	55.505	69.488

Point	X	Y
P_3	58.995	30.025
P_4	19.732	21.191

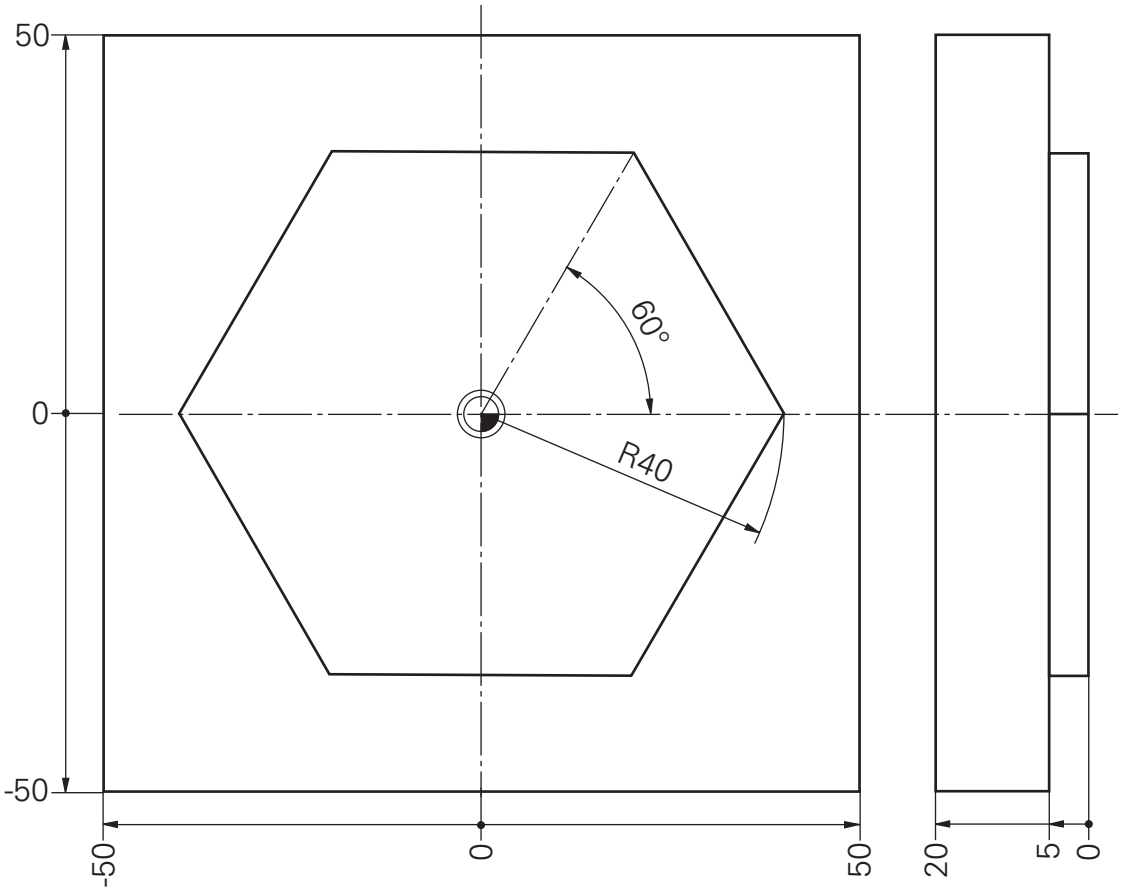
Solution: **Circular arcs**



Complete program

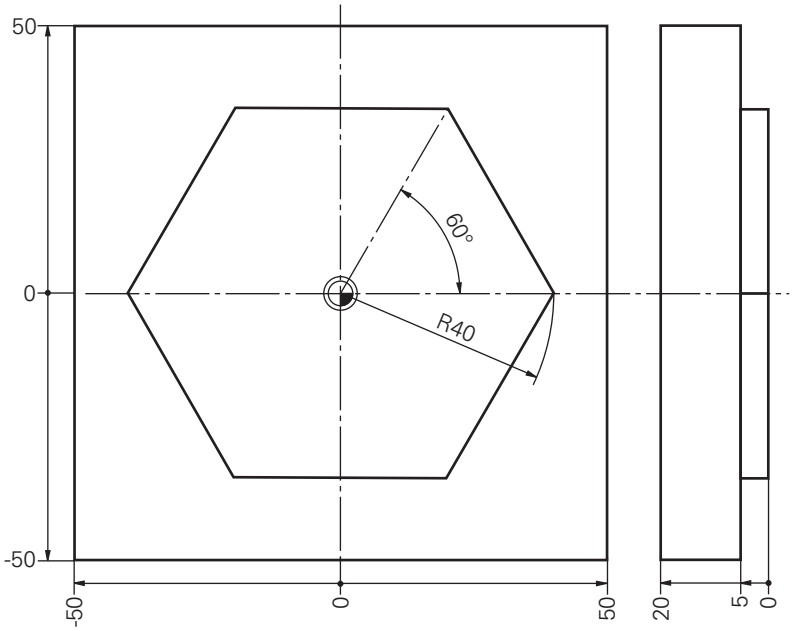
```
%62158 G71 *
N5    G30 G17 X+0 Y+0 Z-20 *
N10   G31 G90 X+100 Y+100 Z+0 *
N15   T13 G17 S2500 * ..... R20
N20   G00 G40 G90 Z+100 M03 * ..... CLEARANCE HEIGHT
N25   X-30 Y+30 * ..... AUXILIARY POINT
N30   Z-5 * ..... DEPTH
N35   G01 G41 X+5 Y+30 F250 * ..... APPROACH STARTING POINT OF
N35   G26 R3 * ..... CONTOUR TANGENTIALLY
N40   I+15 J+30 * ..... CIRCLE CENTER
N45   G02 X+6,645 Y+35,495 *
N50   G06 X+55,505 Y+69,488 * ..... TANGENTIAL CIRCULAR PATH
N55   G05 X+58,995 Y+30,025 R-20 * ..... CIRCULAR PATH WITH RADIUS;
                                        DIRECTION OF ROTATION
                                        PROGRAMMED LAST
N60   G06 X+19,732 Y+21,191 *
N65   G02 X+5 Y+30 *
N70   G27 R3 * ..... DEPART TANGENTIALLY
N75   G01 G40 X-30 Y+30 *
N80   G00 Z+100 M30 *
N999999 %62158 G71 *
```

Task: **Hexagon (polar)** Program(s): _____



Begin program	*%62159 G71*
Define workpiece blank	*G30 G . . . X . . . Y . . . Z . . .* *G31 G . . . X . . . Y . . . Z . . .*
Activate tool	*T . . . G . . . S . . .*
Move to clearance height	*G00 Z . . .*
Define pole	*I . . . J . . .*
Auxiliary point in polar coord.	*G10 R . . . H . . .*
Plunging depth	*G00 Z . . .*
First contour point	*G11 . . .*
Approach tangentially	*G26 R . . .*
Contour ⋮	*G11 . . .* ⋮
Depart tangentially	*G27 R . . .*
Retract tool, PGM end	*G00 Z . . .*

Solution: **Hexagon (polar)**

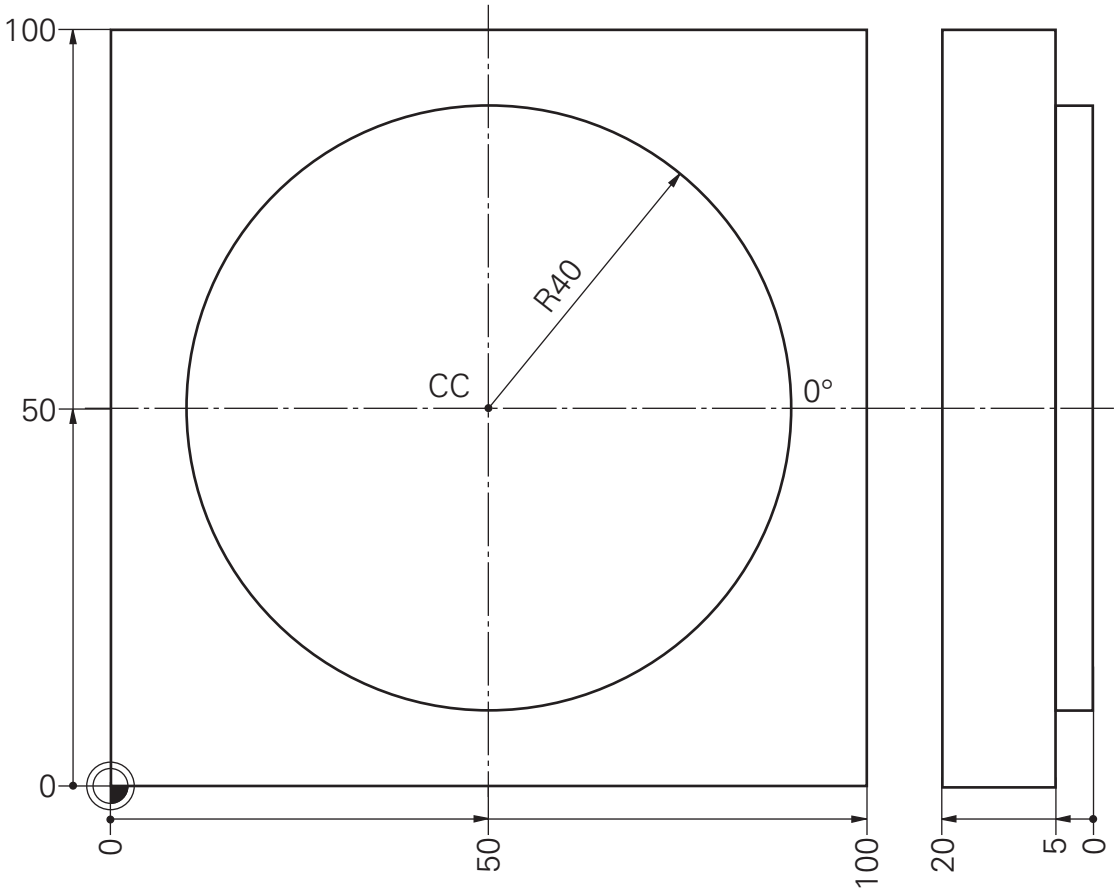


Complete program

```
%62159 G71 *
N5   G30 G17 X-50 Y-50 Z-20 *
N10  G31 G90 X+50 Y+50 Z+0 *
N15  T13 G17 S2500 * ..... R20
N20  G00 G40 G90 Z+100 M03 *
N25  I+0 J+0 * ..... POLE
N30  G10 R+80 H+0 * ..... POLAR AUXILIARY POINT
N35  Z-5 *
N40  G11 G42 H+0 R+40 F250 * ..... APPROACH STARTING POINT OF
N40  G26 R4 * ..... CONTOUR TANGENTIALLY
N45  G11 H+60 *
N50  H+120 *
N55  H+180 *
N60  H+240 *
N65  H+300 *
N70  H+0 *
N75  G27 R4 * ..... DEPART TANGENTIALLY
N80  G11 G40 H+0 R+80 * ..... POLAR AUXILIARY POINT
N85  G00 Z+100 M30 *
N999999 %62159 G71 *
```

Task: **Circle (polar) CP**

Program(s): _____



Begin program
Define workpiece blank

Activate tool
Move to clearance height

Define pole

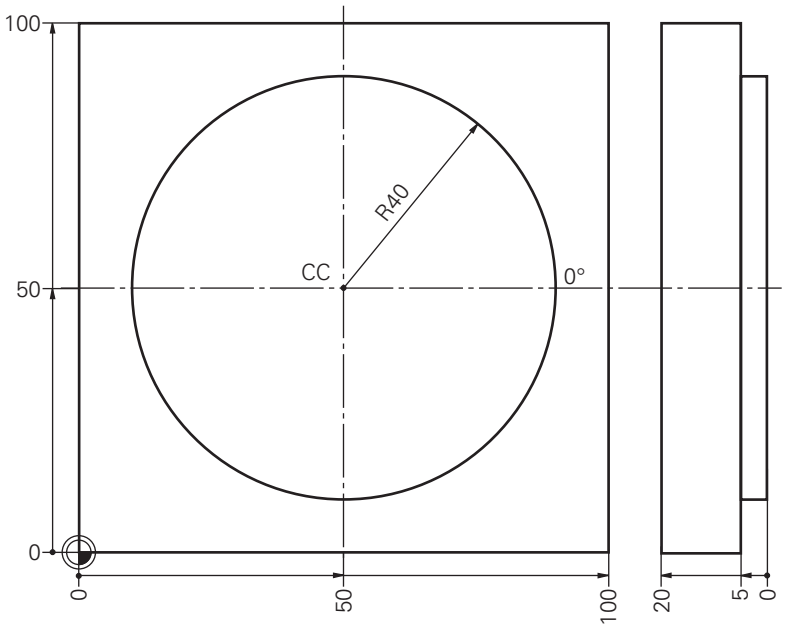
Auxiliary point in polar coord.

Contour

Auxiliary point

Retract tool, PGM end

Solution: **Circle (polar) CP**

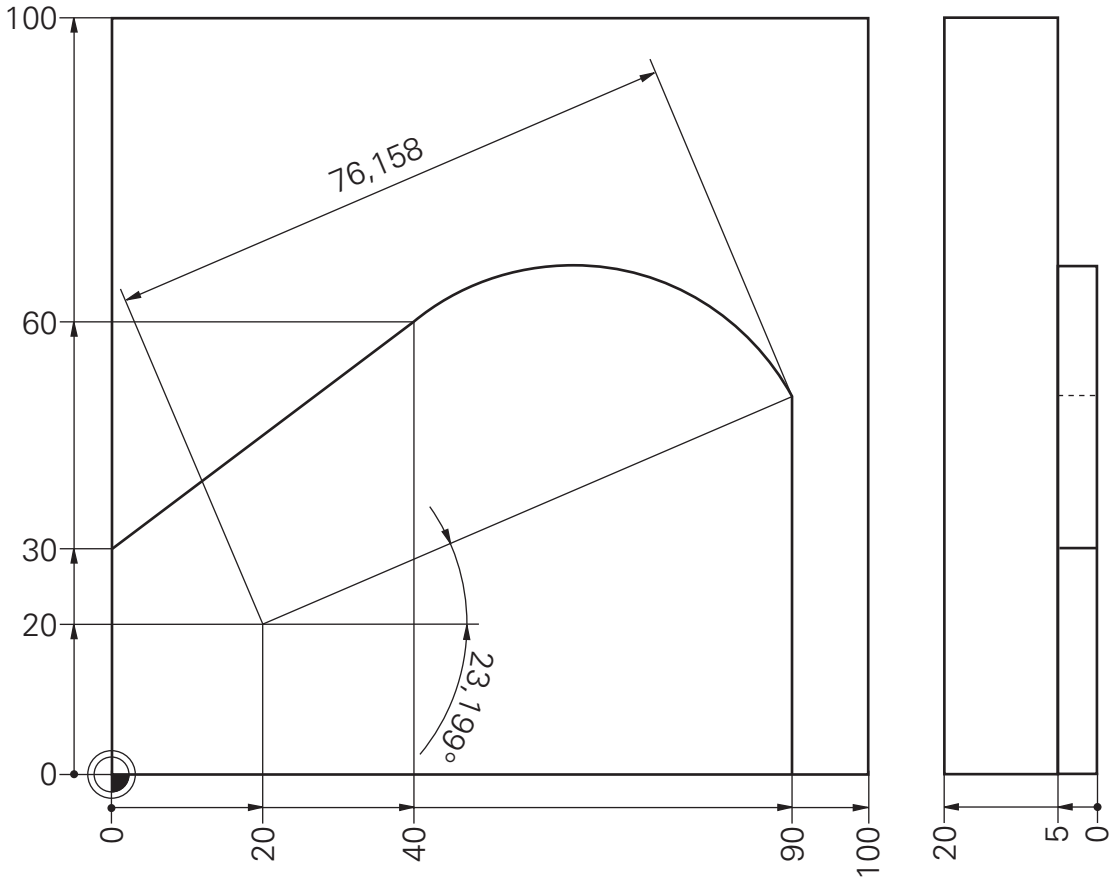


Complete program

```
%62160 G71 *
N5   G30 G17 X+0 Y+0 Z-20 *
N10  G31 G90 X+100 Y+100 Z+0 *
N15  T13 G17 S2500 * ..... R20
N20  G00 G40 G90 Z+100 M03 *
N25  I+50 J+50* ..... POLE
N30  G10 R+80 H+180* ..... AUXILIARY POINT
N35  G00 Z-5 *
N40  G11 G41 R+40 H+180 F250* ..... APPROACH STARTING POINT OF
N45  G26 R3* ..... CONTOUR TANGENTIALLY
N50  G12 G91 H+360* ..... CIRCULAR PATH (POLAR)
N55  G27 R3* ..... DEPART TANGENTIALLY
N60  G11 G40 G90 H+180 R+80 *
N65  G00 Z+100 M30 *
N999999 %62160 G71 *
```

Task: **Circular path with tangential connection (polar) CTP**

Program(s): _____



Begin program
Define workpiece blank

Activate tool
Move to clearance height

Define pole

Auxiliary point

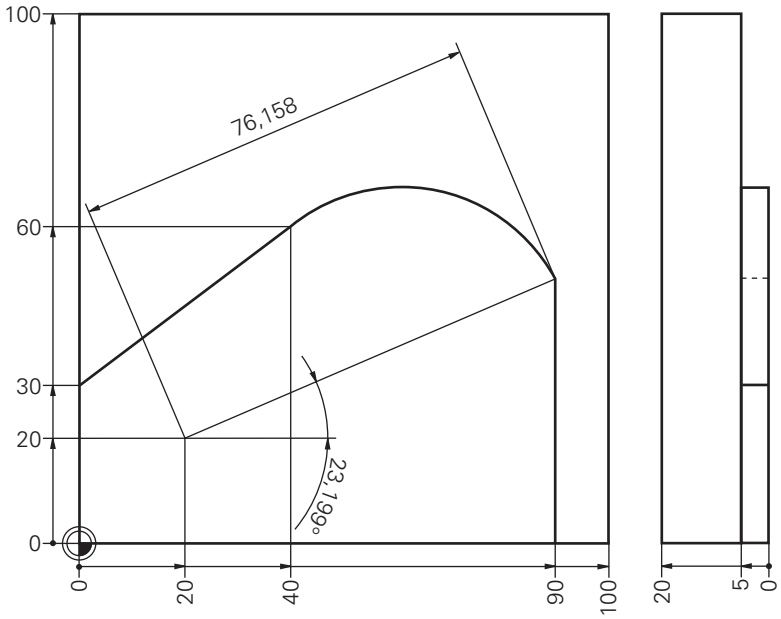
Contour

Auxiliary point

Retract tool, PGM end

Solution:

Circular path with tangential connection (polar) CTP

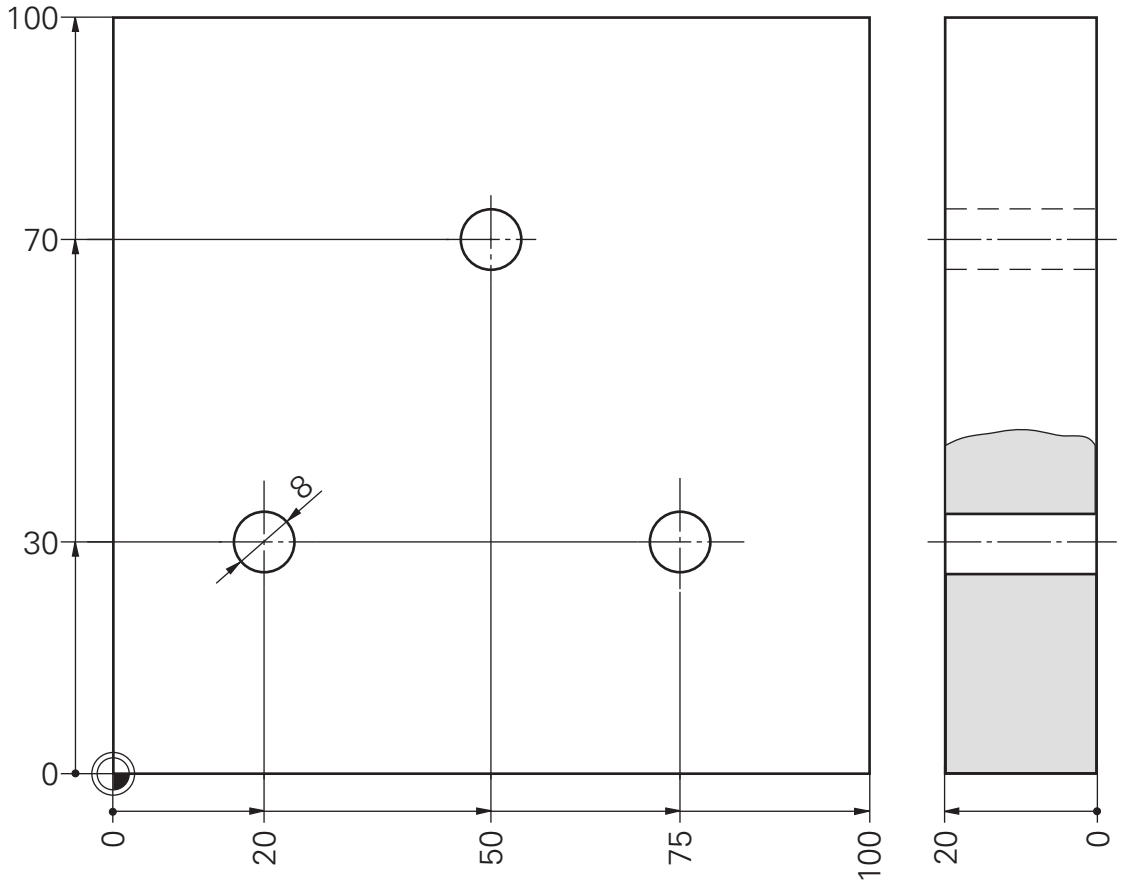


Complete program

```
%62161 G71 *
N5    G30 G17 X+0 Y+0 Z-20 *
N10   G31 G90 X+100 Y+100 Z+0 *
N15   T13 G17 S4000 * ..... R20
N20   G00 G40 G90 Z+100 M03 *
N25   X-30 Y-30* ..... AUXILIARY POINT
N30   Z-5 *
N35   G01 G41 X+0 Y+0 F250* ..... APPROACH STARTING POINT OF
N40   G26 R3* ..... CONTOUR TANGENTIALLY
N45   G01 Y+30 *
N50   X+40 Y+60 *
N55   I+20 J+20* ..... POLE
N60   G16 H+23,199 R+76,158* ..... TANGENTIAL CIRC. PATH (POLAR)
N65   G01 X+90 Y+0*
N70   G40 X+110 Y+10* ..... DEPART
N75   G00 Z+100 M30 *
N999999 %62161 G71 *
```

Task: **Drilling cycle**

Program(s): _____



Begin program
Define workpiece blank

Activate tool
Define cycle
Move to clearance height

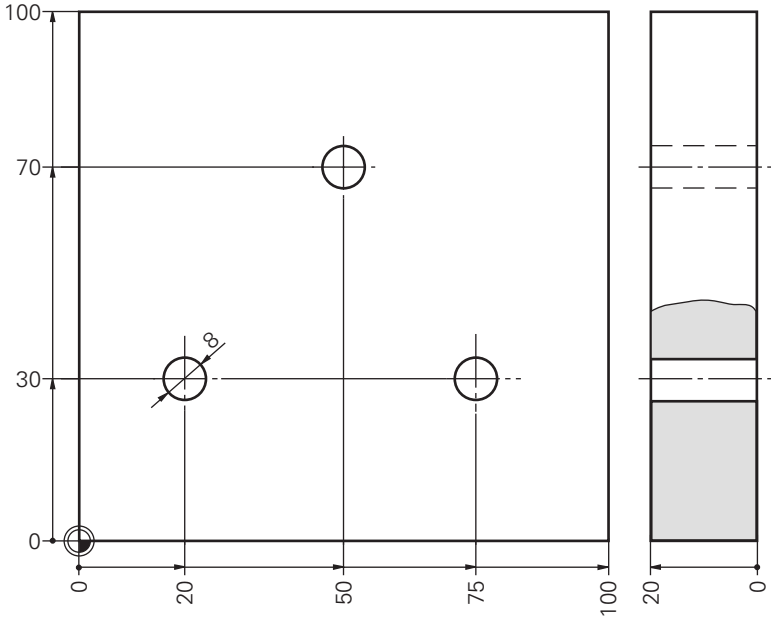
Starting point 1st hole / cycle call

2nd hole / cycle call

3rd hole / cycle call

Retract tool, PGM end

Solution: **Drilling cycle**

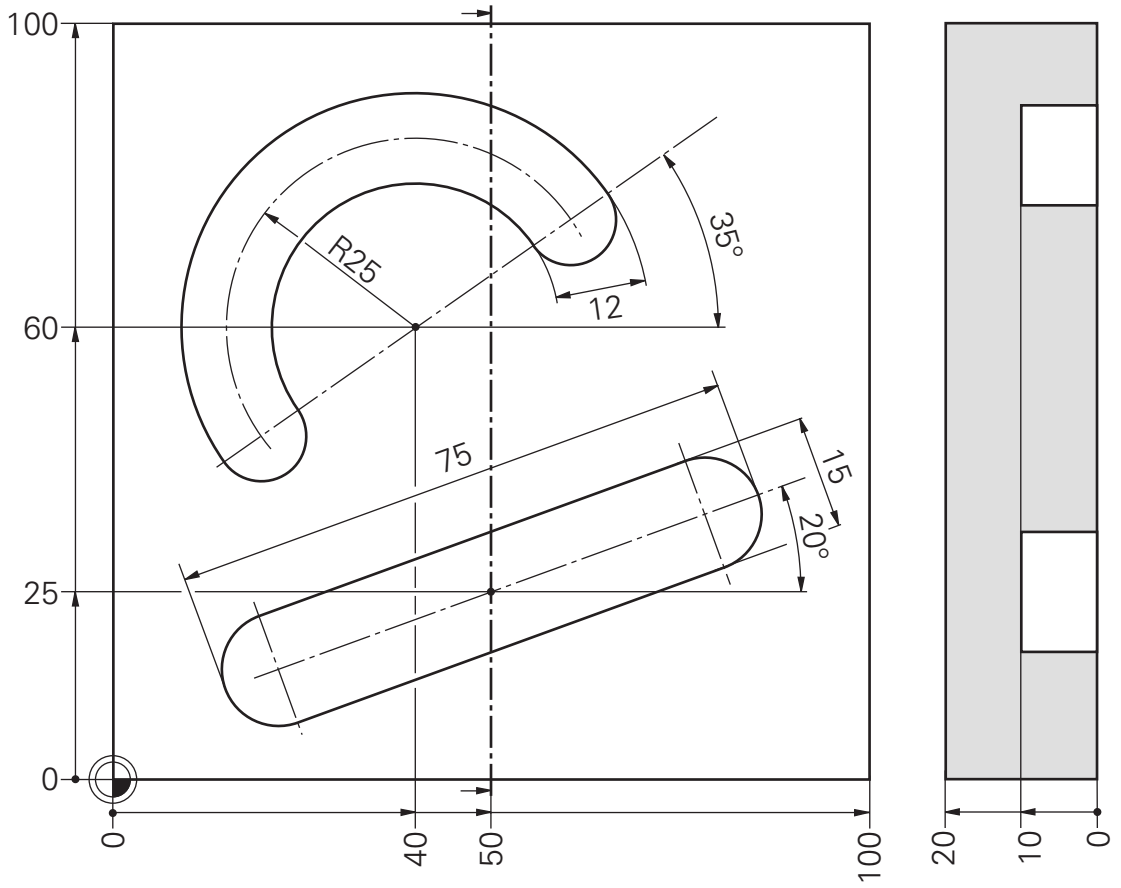


Complete program

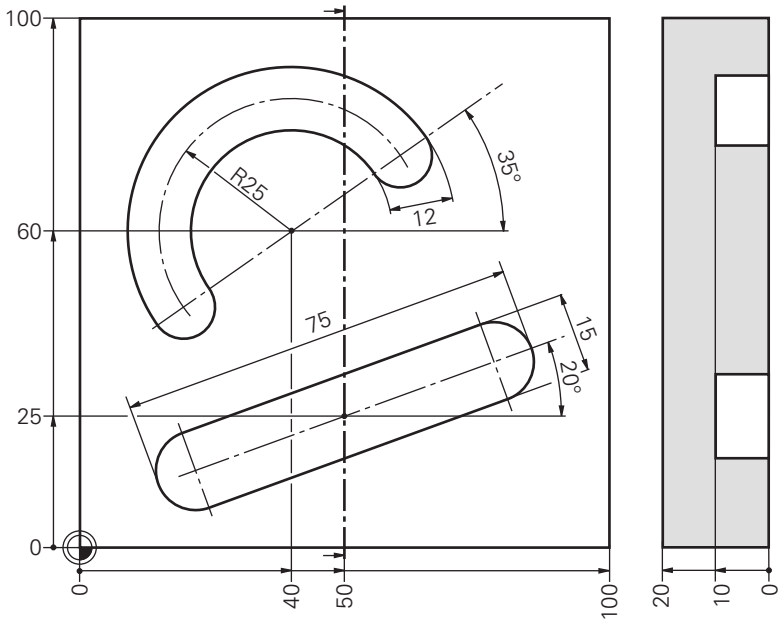
```
%62170 G71 *
N5  G30 G17 X+0 Y+0 Z-20 *
N10 G31 G90 X+100 Y+100 Z+0 *
N15 T7 G17 S1000 * ..... R4
N20 G200
    Q200=2 ..... SETUP CLEARANCE
    Q201=-23 ..... DEPTH
    Q206=150 ..... FEED RATE FOR PLUNGING
    Q202=5 ..... PLUNGING DEPTH
    Q210=0 ..... DWELL TIME AT TOP
    Q203=+0 ..... SURFACE COORDINATE
    Q204=2 ..... 2ND SETUP CLEARANCE
    Q211=0 * ..... DWELL TIME AT DEPTH
N25 G00 G40 G90 Z+100 M03 *
N30 G00 X+20 Y+30 M99 * ..... STARTING POSITION
N35 G00 X+50 Y+70 M99 * ..... 2ND HOLE
N40 G00 X+75 Y+30 M99 * ..... 3RD HOLE
N45 G00 Z+100 M30 *
N999999 %62170 G71 *
```

Task: **Slot plate**

Program(s): _____



Solution: **Slot plate**

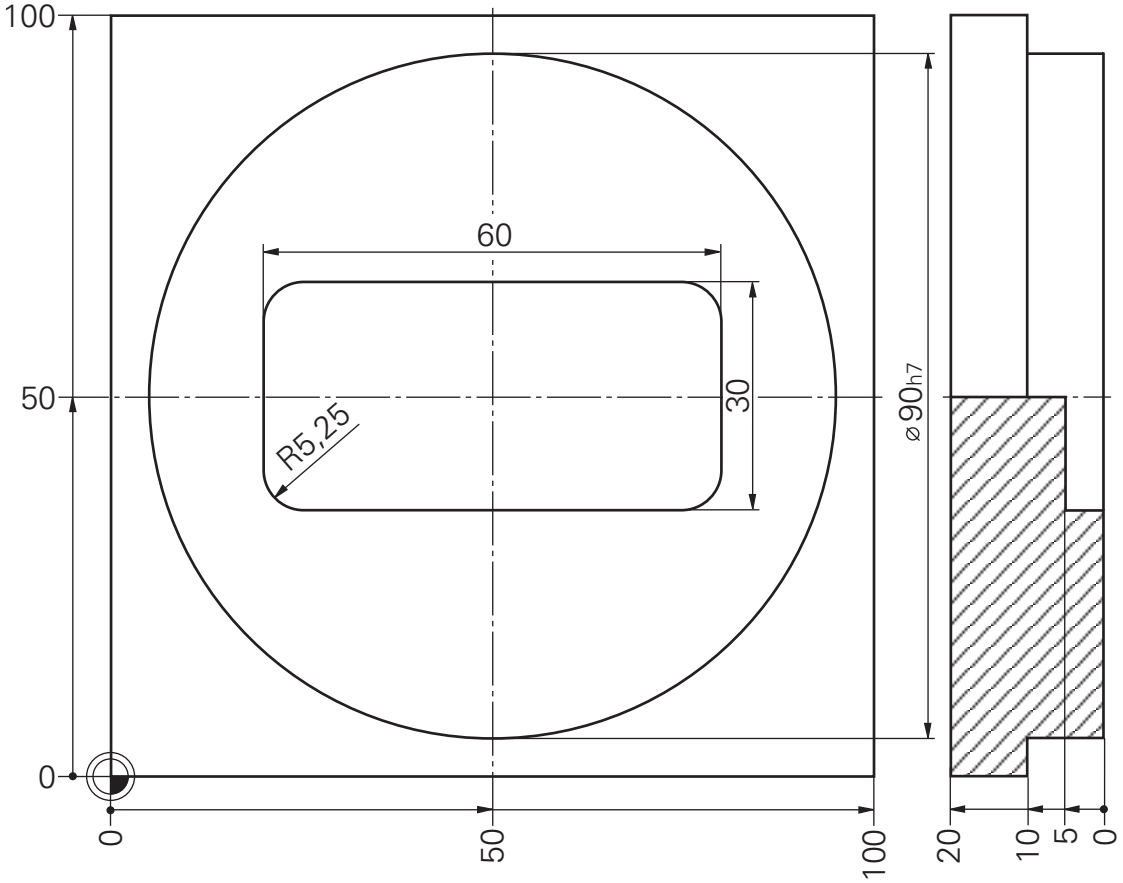


Complete program

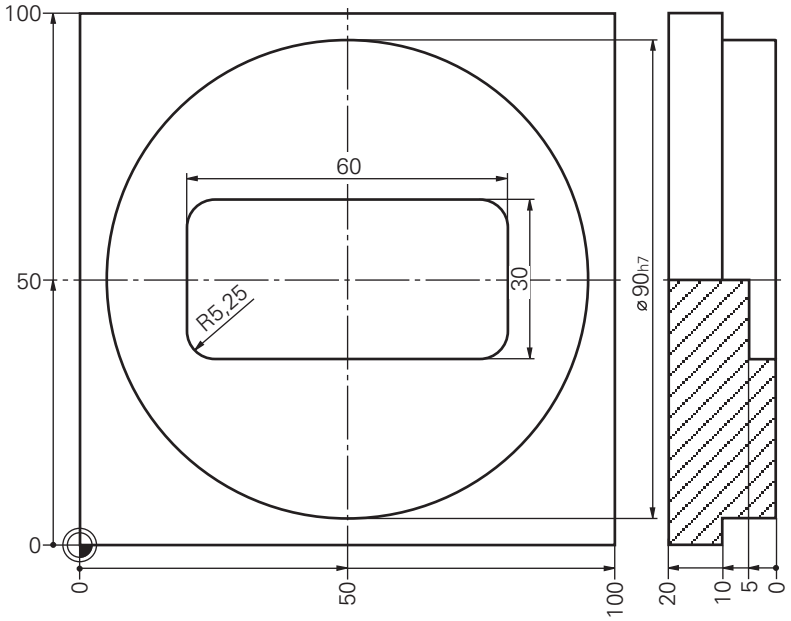
```
%62172 G71 *
N5   G30 G17 X+0 Y+0 Z-20 *
N10  G31 G90 X+100 Y+100 Z+0 *
N15  T8 G17 S1000 *

N20  G00 G40 G90 Z+100 M03 *
N25  G210
     Q200=2 ..... SETUP CLEARANCE
     Q201=-10 ..... DEPTH
     Q207=100 ..... FEED RATE FOR MILLING
     Q202=5 ..... PLUNGING DEPTH
     Q215=0 ..... MACHINING OPERATION
     Q203=+0 ..... SURFACE COORDINATE
     Q204=2 ..... 2ND SETUP CLEARANCE
     Q216=+50 ..... CENTER IN 1ST AXIS
     Q217=+25 ..... CENTER IN 2ND AXIS
     Q218=75 ..... 1ST SIDE LENGTH
     Q219=15 ..... 2ND SIDE LENGTH
     Q224=+20 ..... ANGLE OF ROTATION
     Q338=5* ..... INFEED FOR FINISHING
N30  M99*

N35  G211
     Q200=2 ..... SETUP CLEARANCE
     Q201=-10 ..... DEPTH
     Q207=100 ..... FEED RATE FOR MILLING
     Q202=5 ..... PLUNGING DEPTH
     Q215=0 ..... MACHINING OPERATION
     Q203=+0 ..... SURFACE COORDINATE
     Q204=2 ..... 2ND SETUP CLEARANCE
     Q216=+40 ..... CENTER IN 1ST AXIS
     Q217=+60 ..... CENTER IN 2ND AXIS
     Q244=50 ..... PITCH CIRCLE DIAMETER
     Q219=12 ..... 2ND SIDE LENGTH
     Q245=+35 ..... STARTING ANGLE
     Q248=180 ..... ANGULAR LENGTH
     Q338=5* ..... INFEED FOR FINISHING
N40  M99 *

N45  G00 Z+100 M30 *
N999999 %62172 G71 *
```

Task: **Die I**

Program(s): _____



Solution: **Die I**



Complete program

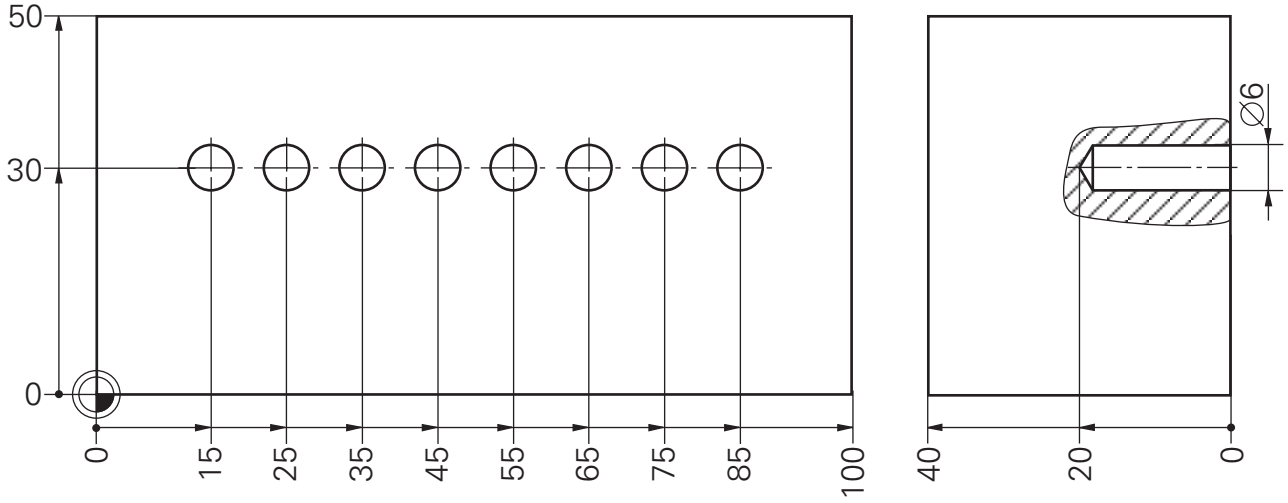
```
%62174 G71 *
N5   G30 G17 X+0 Y+0 Z-20 *
N10  G31 G90 X+100 Y+100 Z+0 *
N15  T13 G17 S800 *
N20  G00 G40 G90 Z+100 M03 *
N25  G215 ..... FINISH CYLINDRICAL STUD
     Q200=2 ..... SETUP CLEARANCE
     Q201=-10 ..... DEPTH
     Q206=150 ..... FEED RATE FOR PLUNGING
     Q202=10 ..... PLUNGING DEPTH
     Q207=200 ..... FEED RATE FOR MILLING
     Q203=+0 ..... SURFACE COORDINATE
     Q204=50 ..... 2ND SETUP CLEARANCE
     Q216=+50 ..... CENTER IN 1ST AXIS
     Q217=+50 ..... CENTER IN 2ND AXIS
     Q222=140 ..... WORKPIECE BLANK DIAMETER
     Q223=101* ..... FINISHED PART DIAMETER
N30  M99*
N35  T7 DR+1 G17 S2000 *
N40  G00 G40 G90 Z+100 M03 *
N45  G75 ..... POCKET MILLING
     P01 2 ..... SETUP CLEARANCE
     P02 -5 ..... DEPTH
     P03 5 ..... PLUNGING DEPTH
     P04 100 ..... FEED RATE FOR PLUNGING
     P05 X+60 ..... LENGTH IN X
     P06 Y+30 ..... LENGTH IN Y
     P07 250 ..... FEED RATE FOR MILLING
     P08 7 *
N50  G00 X+50 Y+50 *
N55  Z+2 M99 *
N60  Z+100M06*
```

Solution: **Die I**

```
N65  T8 G17 S1000 *
N70  G00 G40 G90 Z+100 M03 *
N75  G212 ..... POCKET FINISHING
     Q200=2 ..... SETUP CLEARANCE
     Q201=-5 ..... DEPTH
     Q206=250 ..... FEED RATE FOR PLUNGING
     Q202=5 ..... PLUNGING DEPTH
     Q207=250 ..... FEED RATE FOR MILLING
     Q203=+0 ..... SURFACE COORDINATE
     Q204=20 ..... 2ND SETUP CLEARANCE
     Q216=+50 ..... CENTER IN 1ST AXIS
     Q217=+50 ..... CENTER IN 2ND AXIS
     Q218=60 ..... 1ST SIDE LENGTH
     Q219=30 ..... 2ND SIDE LENGTH
     Q220=5,25 ..... CORNER RADIUS
     Q221=0 * ..... ALLOWANCE
N80  M99 *
N85  G215 ..... FINISH CYLINDRICAL STUD
     Q200=2 ..... SETUP CLEARANCE
     Q201=-10 ..... DEPTH
     Q206=250 ..... FEED RATE FOR PLUNGING
     Q202=10 ..... PLUNGING DEPTH
     Q207=250 ..... FEED RATE FOR MILLING
     Q203=+0 ..... SURFACE COORDINATE
     Q204=20 ..... 2ND SETUP CLEARANCE
     Q216=+50 ..... CENTER IN 1ST AXIS
     Q217=+50 ..... CENTER IN 2ND AXIS
     Q222=92 ..... WORKPIECE BLANK DIAMETER
     Q223=90 * ..... FINISHED PART DIAMETER
N90  M99 *
N95  G00 Z+100 M30 *
N999999 %62174 G71 *
```

Task: **Program section repeats - linear hole pattern**

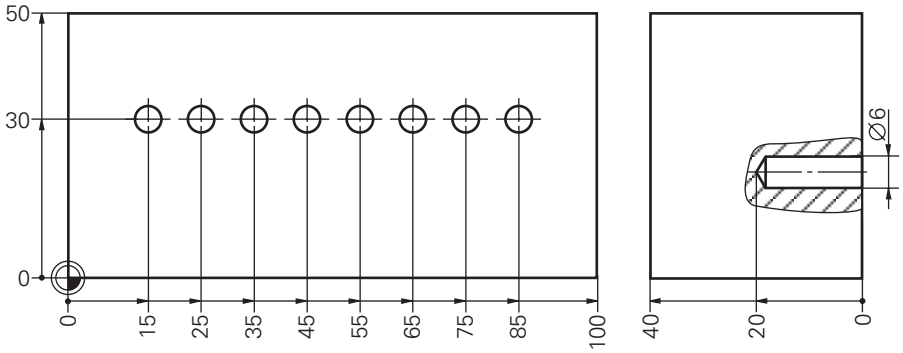
Program(s): _____



Begin program Define workpiece blank	*%62180 G71* *G30 G... X... Y... Z...* *G31 G... X... Y... Z...*
Activate tool	*T... G... S...*
Define cycle Move to clearance height	*G200...* *G00 G40 G90 Z...*
Move to pre-position	*X... Y...*
Define label	*G98 L...*
Traverse movement/ cycle call	*G00 G91 X... M99*
Label call	*L.../...*
Retract tool, PGM end	*...*

Solution:

Program section repeats - linear hole pattern

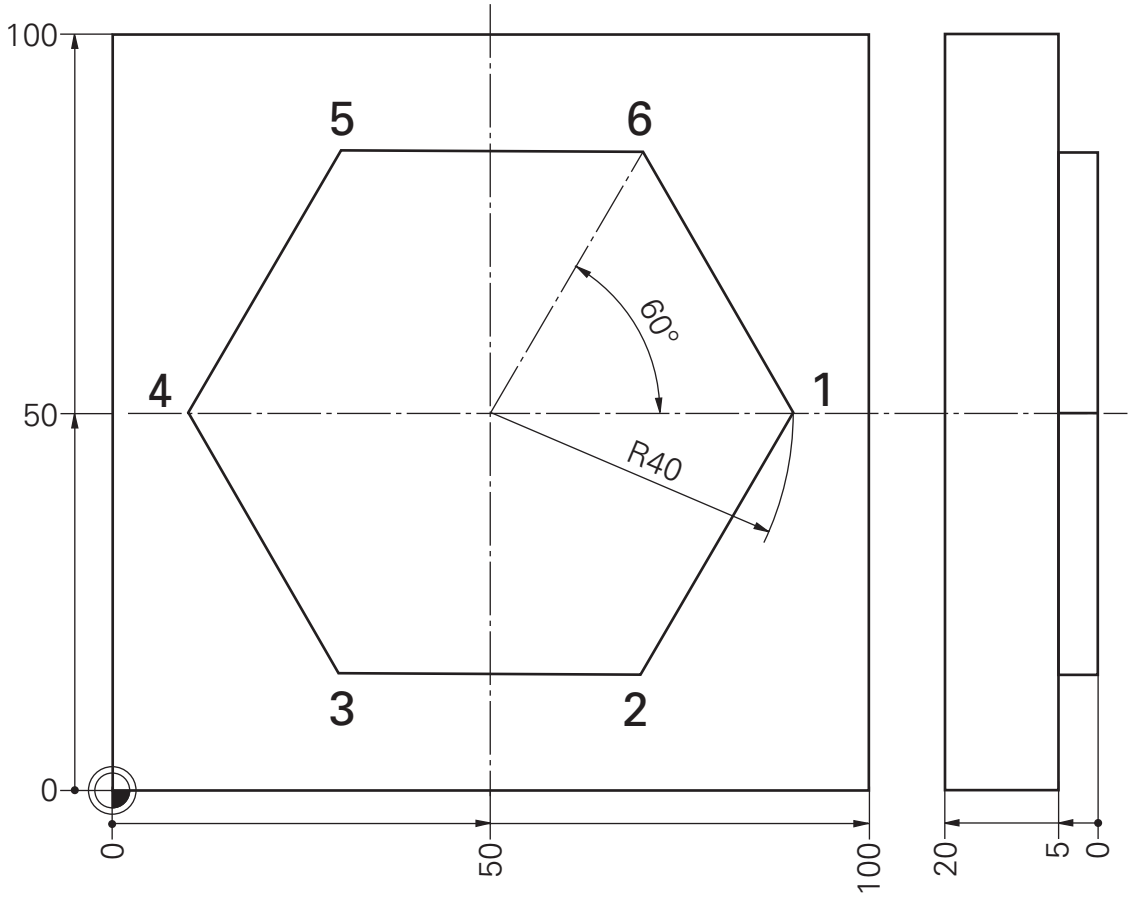


Complete program

```
%62180 G71 *
N5   G30 G17 X+0 Y+0 Z-20 *
N10  G31 G90 X+100 Y+50 Z+0 *
N15  T1 G17 S4000 *
N20  G00 G40 G90 Z+100 M03 *
N25  G200
     Q200=2 ..... SETUP CLEARANCE
     Q201=-20 ..... DEPTH
     Q206=150 ..... FEED RATE FOR PLUNGING
     Q202=4 ..... PLUNGING DEPTH
     Q210=0 ..... DWELL TIME AT TOP
     Q203=+0 ..... SURFACE COORDINATE
     Q204=2 ..... 2ND SETUPT CLEARANCE
     Q211=0 * ..... DWELL TIME AT BOTTOM
N30  G00 X+5 Y+30 * ..... STARTING POSITION
N35  G98 L1 * ..... DEFINE LABEL
N40  G00 G91 X+10 M99 *
N45  L1,7 * ..... LABEL CALL WITH REPEATS
N50  G00 Z+100 M30 *
N999999 %62180 G71 *
```

Task: **Hexagon**

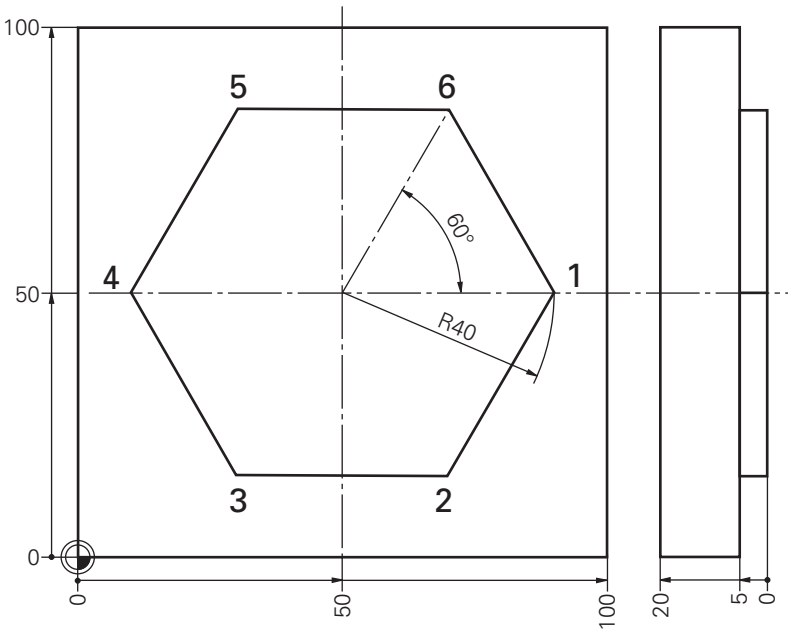
Program(s): _____



Program layout:

Conventional preparations:	*G30/G31*	Define workp. blank
Activate tool	*T . . .*	
Starting position	*G00 G40 G90 . . .*	
	I . . . J . . .	Pole
	G10 R . . . H . . .	Auxiliary point
	G00 Z . . .	Infeed
Approach contour	*G11 . . . / G26 R . . .*	1st contour point
Define label	*G98 L . . .*	
Traverse movement	*G11 G91 H . . .*	
Label call	*L . . . / . . .*	
Retract tool	*G11 G40 G90 H . . .*	Auxiliary point
End	*G00 Z . . .*	

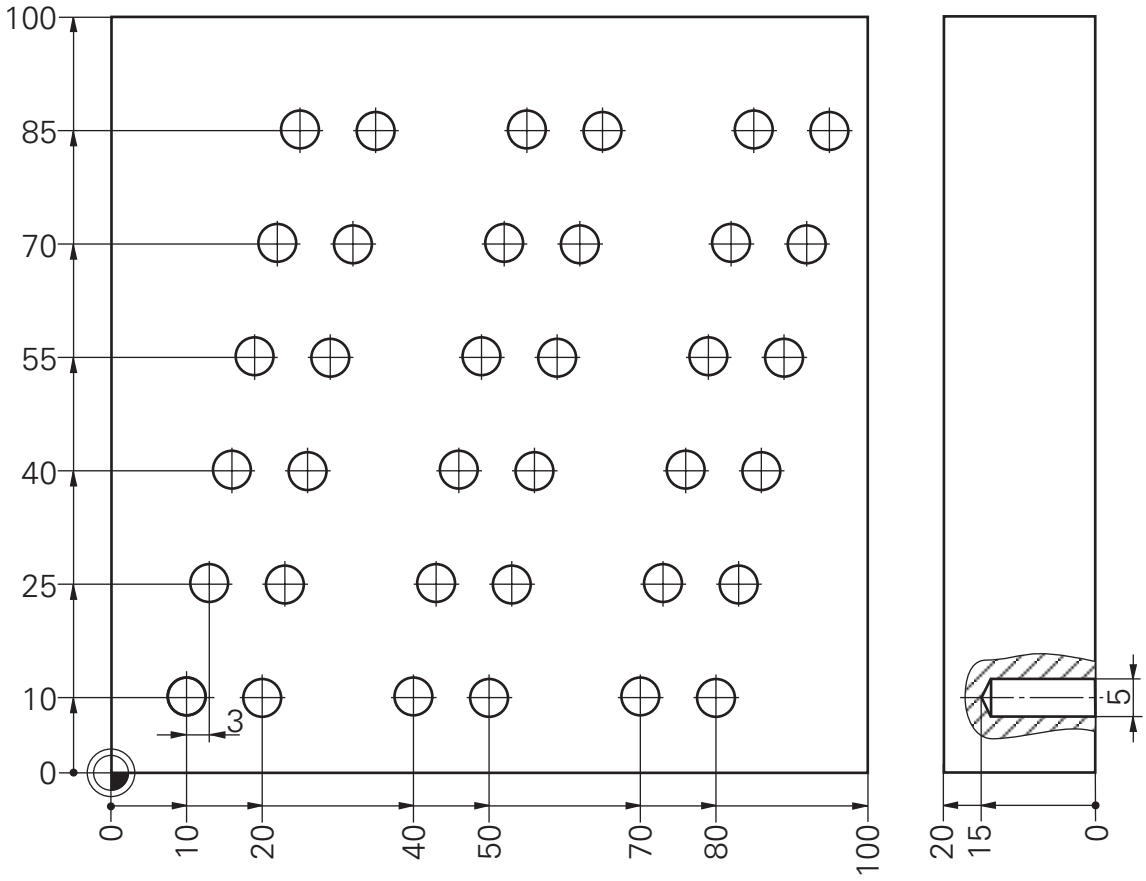
Solution: **Hexagon**



Complete program

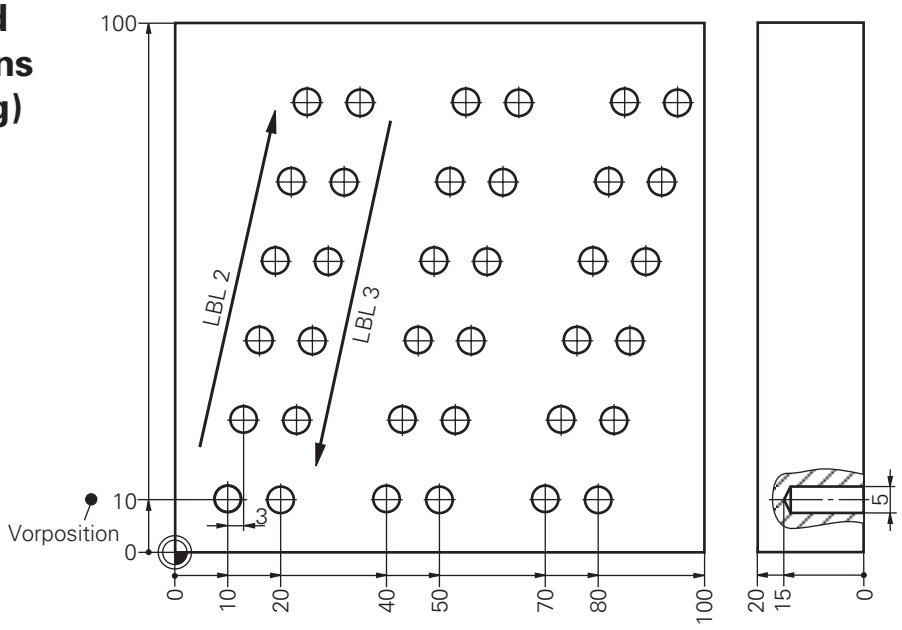
```
%62181 G71 *
N5 G30 G17 X+0 Y+0 Z-20 *
N10 G31 G90 X+100 Y+100 Z+0 *
N15 T12 G17 S2000 * ..... R15
N20 G00 G40 G90 Z+100 M03 *
N25 I+50 J+50 * ..... POLE
N30 G10 R+80 H+0 * ..... AUXILIARY POINT
N35 G00 Z-5 *
N40 G11 G41 R+40 F250 * ..... CONTOUR STARTING POINT
N45 G25 R3 *
N50 G98 L1 * ..... DEFINE LABEL
N55 G11 G91 H-60 *
N60 L1,4 * ..... LABEL CALL WITH REPEATS
N65 G11 G91 H-60 *
N65 G26 R3 *
N70 G11 G40 G90 H+0 R+80 * ..... AUXILIARY POINT
N75 G00 Z+100 M30 *
N999999 %62181 G71 *
```

Task: **Drilled plate - slanted columns** Program(s): _____



Program layout: **Drilled plate - slanted columns**

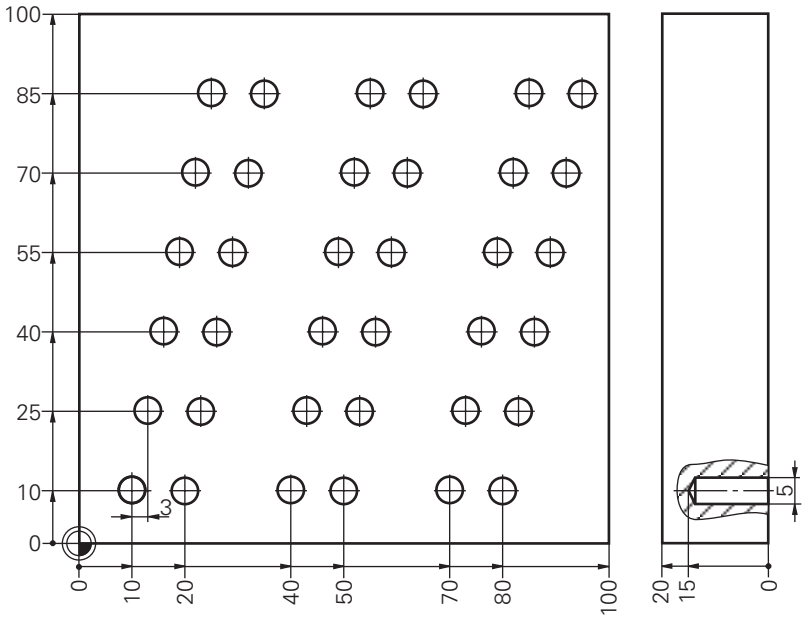
Move up and down columns (meandering)



Drilling pattern

G00 X . . . Y . . .	Absolut pre-position
G98 L 1	Define label 1
G91 X . . . M99	Cross over to 1st hole
G98 L 2	Define label 2
X . . . Y . . . M99	Move up the column
L 2, . . .	Cross over to 2nd column
X . . . M99	
G98 L 3	Define label 3
X . . . Y . . . M99	Move down the column
L 3, . . .	Remaining groups
L 1, . . .	

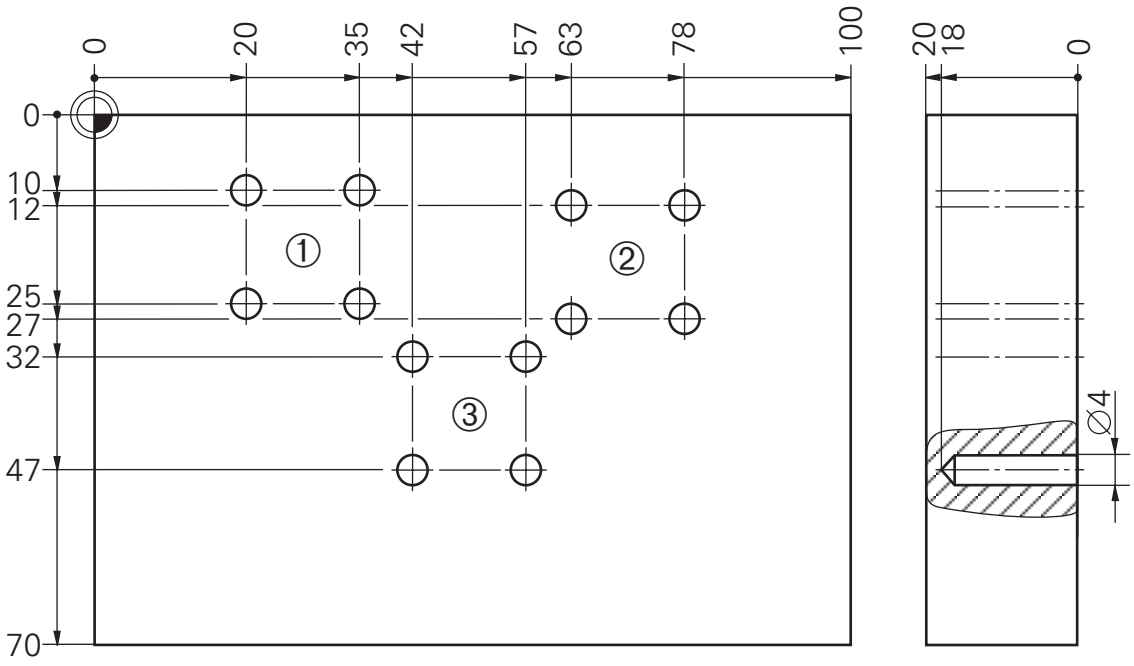
Solution: **Drilled plate - slanted columns**



MAIN PROGRAM

```
%62182 G71 *
N5   G30 G17 X+0 Y+0 Z-20 *
N10  G31 G90 X+100 Y+100 Z+0 *
N15  T5 G17 S4000 * ..... R2:5
N20  G00 G40 G90 Z+100 M03 *
N25  G200 ..... DRILLING
     Q200=2 ..... SETUP CLEARANCE
     Q201=-15 ..... DEPTH
     Q206=250 ..... FEED RATE FOR PLUNGING
     Q202=8 ..... PLUNGING DEPTH
     Q210=0 ..... DWELL TIME AT TOP
     Q203=+0 ..... SURFACE COORDINATE
     Q204=20 ..... 2ND SETUP CLEARANCE
     Q211=0 * ..... DWELL TIME AT DEPTH
N30  G00 X-10 Y+10 *
N35  G98 L1 *
N40  G00 G91 X+20 M99 *
N45  G98 L2 *
N50  G00 X+3 Y+15 M99 *
N55  L2,4 *
N60  G00 X+10 M99 *
N65  G98 L3 *
N70  G00 X-3 Y-15 M99 *
N75  L3,4 *
N80  L1,2 *
N85  G00 G90 Z+100 M30 *
N999999 %62182 G71 *
```

Task: **Subprogram (group of holes)** Program(s): _____



Begin program

% . . . G71	
• •	
T . . .	Activate tool
G . . .	Define cycle
G00 Z+ . . .	Move to clear. height
G00 X . . . Y . . .	Start. pos. hole group ①
L . . . , . . .	Call SPGM
G00 X . . . Y . . .	Start. pos. hole group ②
L . . . , . . .	Call SPGM
G00 X . . . Y . . .	Start. pos. hole group ③
L . . . , . . .	Call SPGM

Retract tool, end *G00 G40 Z+100 M2*

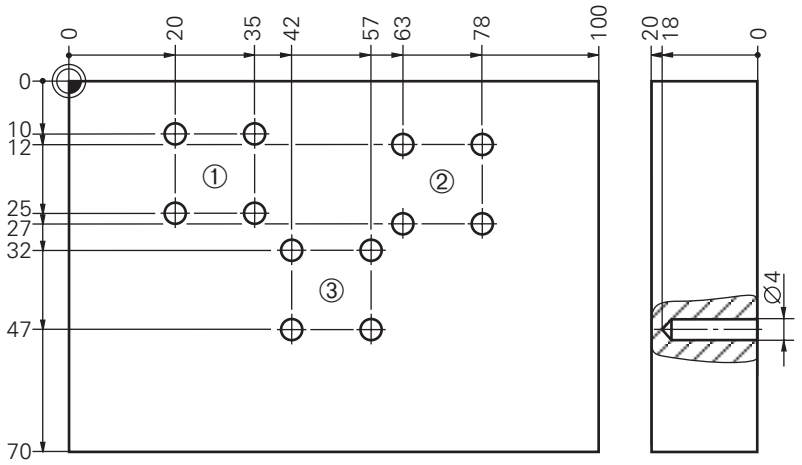
SPGM

G98 L . . .

SPGM end

G98 L 0

Solution: **Subprogram (group of holes)**



MAIN PROGRAM

```
%62186 G71 *
N10  G30 G17 X+0 Y-70 Z-20 *
N20  G31 G90 X+100 Y+0 Z+0 *
N30  T4 G17 S2000 * ..... TOOL CALL, R2
N40  G200 ..... DRILLING
     Q200=2 ..... SETUP CLEARANCE
     Q201=-18 ..... DEPTH
     Q206=150 ..... FEED RATE FOR PLUNGING
     Q202=7 ..... PLUNGING DEPTH
     Q210=0 ..... DWELL TIME ON TOP
     Q203=+0 ..... SURFACE COORDINATE
     Q204=50 ..... 2ND SETUP CLEARANCE.
     Q211=0 * ..... DWELL TIME AT BOTTOM
N50  G00 G40 G90 Z+100 M03 * ..... CLEARANCE HEIGHT
N60  X+20 Y-10 * ..... STARTING POINT HOLE GROUP①
N70  L1,0 * ..... CALL SPGM

N80  G00 X+63 Y-12 * ..... STARTING POINT HOLE GROUP②
N90  L1,0 * ..... CALL SPGM

N100 G00 X+42 Y-32 * ..... STARTING POINT HOLE GROUP③
N110 L1,0 * ..... CALL SPGM
```

Retract tool, end

```
N120 G00 G40 G90 Z+100 M30 *
```

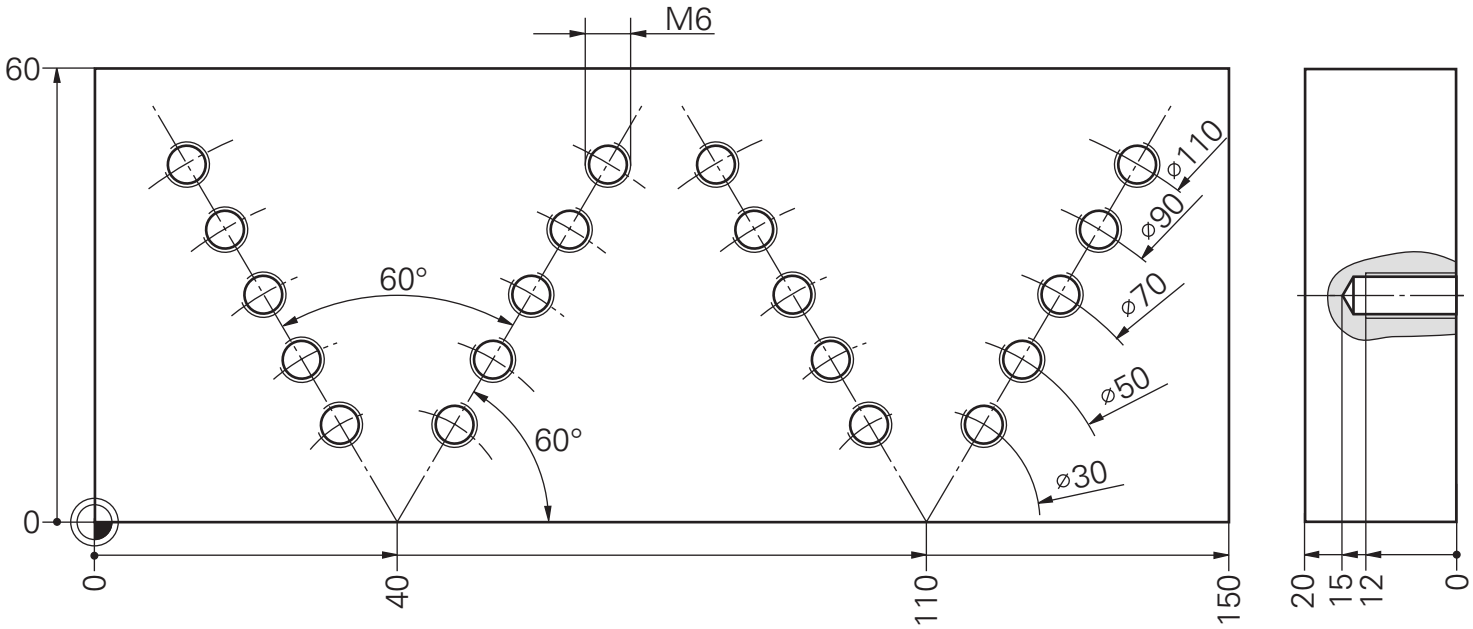
SPGM

```
N130 G98 L1 *
N140 M99 *
N150 G00 G91 X+15 M99 *
N160 G00 Y-15 M99 * ..... DRILLING PATTERN
N170 G00 X-15 M99 *
N180 G90 *
N190 G98 L0 *
N999999 %62186 G71 *
```

SPGM, END

Task: **Bolt hole circle segments with several tools**

Program(s): _____



Program layout: **Nesting for double bolt-hole circles**

Conventional preparations: *G30/G31*

Centering

```
T . . .
G200 . . . / G00 Z+100
L 1,0
```

Drilling

```
T . . .
G . . .
L 1,0
```

Tapping

```
T . . .
G . . .
L 1,0
```

Retract tool, end *G00 Z100 M2*

SPGM1

```
G98 L 1
I . . . J . . .
L 2,0
I . . . J . . .
L 2,0
```

Circle center left

Call bolt-hole circle segm.

Circle center right

Call bolt-hole circle segm.

End of SPGM1

```
G98 L 0
```

SPGM2, bolt-hole circle segm.

```
G98 L 2
G10 R . . . H . . . M3
G00 Z+2 M99
G98 L 3
■
L 3, . . .
LP PR . . . PA . . .
G98 L 4
■
L 4, . . .
```

Starting position

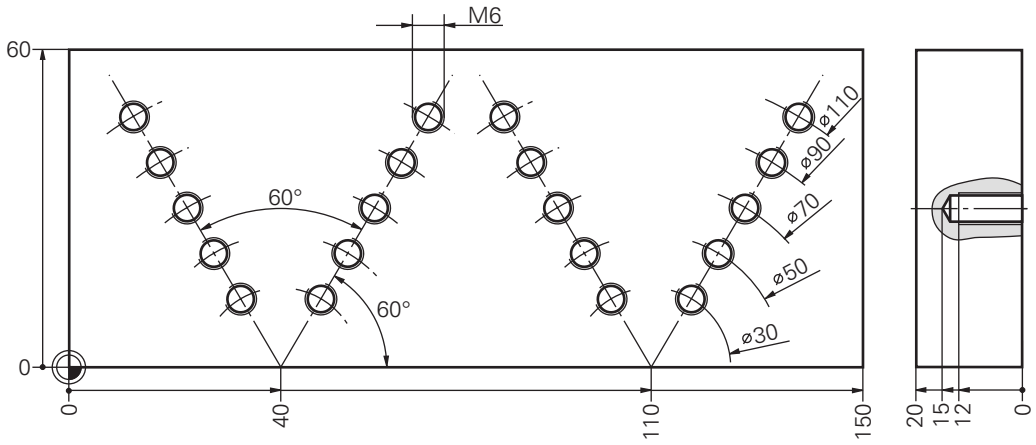
Remaining holes

Partial repeats

End of SPGM2

```
G98 L 0
```

Solution: **Bolt hole circle segments with several tools**



MAIN PROGRAM

```
%62187 G71 *
N10  G30 G17 X+0 Y+0 Z-20 *
N20  G31 G90 X+150 Y+60 Z+0 *
N30  T4 G17 S2500 * ..... R2
N40  G00 G40 G90 Z+100 M03 *
N50  G200 ..... CIRCLE CENTER
     Q200=2 ..... SETUP CLEARANCE
     Q201=-3,2 ..... DEPTH
     Q206=150 ..... FEED RATE FOR PLUNGING
     Q202=3,2 ..... PLUNGING DEPTH
     Q210=0 ..... DWELL TIME AT TOP
     Q203=+0 ..... SURFACE COORDINATE
     Q204=2 ..... 2ND SETUP CLEARANCE
     Q211=0* ..... DWELL TIME AT BOTTOM
N60  L1,0 *

N70  G00 Z+100 M06 *
N80  T5 G17 S2000 * ..... R2.5
N90  G00 G40 G90 Z+100 M03 *
N100 G203 ..... UNIVERSAL DRILLING
     Q200=2 ..... SETUP CLEARANCE
     Q201=-15 ..... DEPTH
     Q206=150 ..... FEED RATE FOR PLUNGING
     Q202=5 ..... PLUNGING DEPTH
     Q210=0 ..... DWELL TIME AT TOP
     Q203=+0 ..... SURFACE COORDINATE
     Q204=2 ..... 2ND SETUP CLEARANCE
     Q212=1 ..... DECREMENT
     Q213=0 ..... NUMBER OF CHIP BREAKINGS
     Q205=3 ..... MIN. PLUNGING DEPTH
     Q211=0 ..... DWELL TIME AT BOTTOM
     Q208=30000 ..... RETRACTION FEED RATE
     Q256=0,2 * ..... CHIP BREAKING RETRACTION
N110 L1,0 *

N120 G00 G90 Z+100 M06 *
N130 T6 G17 S300 * ..... R3
N140 G00 G40 G90 Z+100 M03 *
N150 G84 ..... TAPPING
     P01 5
     P02 -15
     P03 0
     P04 300 *
N160 L1,0 *
N170 G00 G40 G90 Z+100 M30 *
```

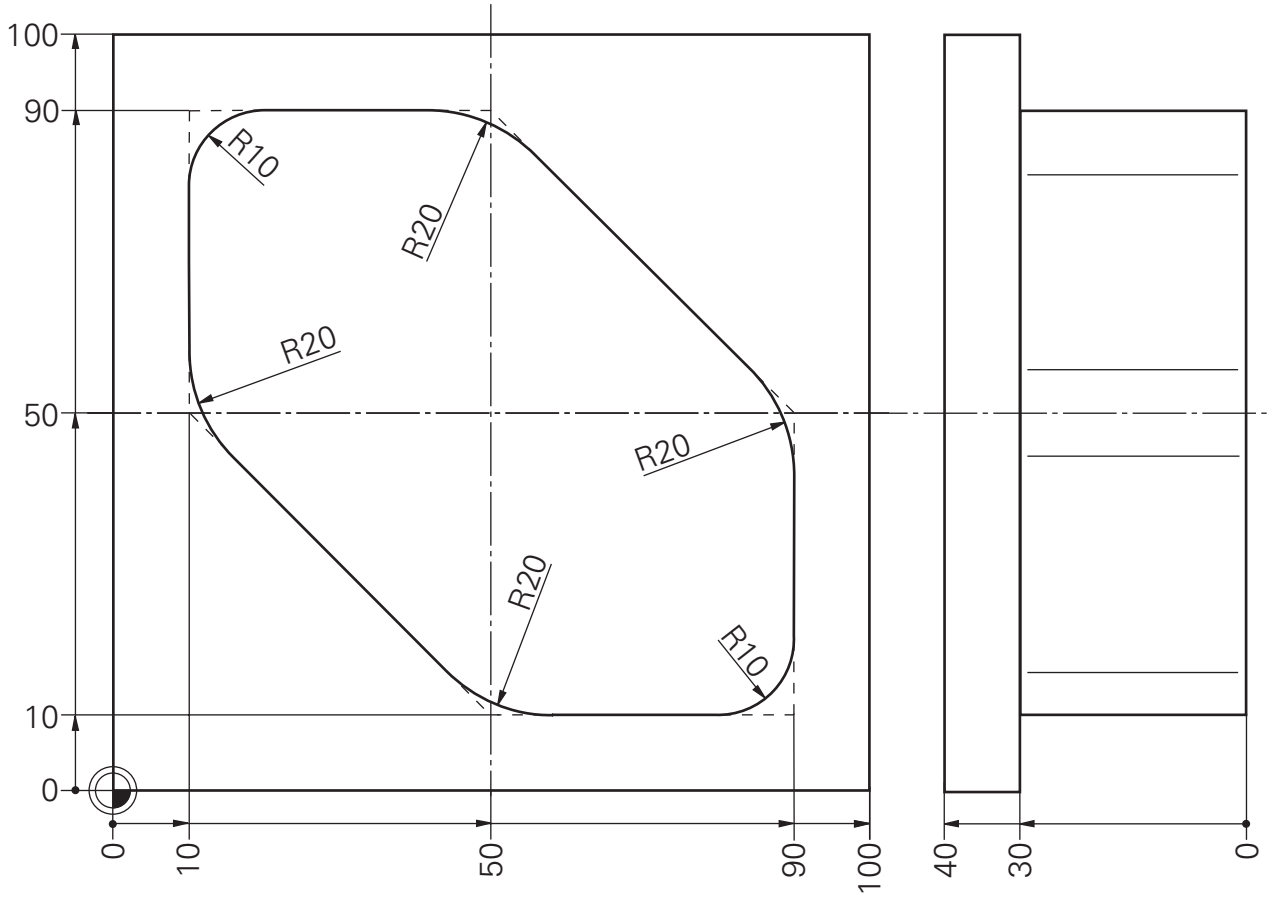
Solution: **Bolt hole circle segments with several tools**

SPGM

```
N180  G98L1*
N190 I+40 J+0 *
N200 L2,0 *
N210 I+110 J+0 *
N220 L2,0 *
N230 G98 L0 *

N240 G98 L2 *
N250 G10 G90 R+55 H+120 *
N260 G00 Z+5 M99 *
N270 G98 L3 *
N280 G10 G91 R-10 M99 *
N290 L3,3 *
N300 G10 G90 R+15 H+60 M99 *
N310 G98 L4 *
N320 G10 G91 R+10 M99 *
N330 L4,3 *
N340 G90 *
N340 G98 L0 *

N999999 %62187 G71 *
```

Task: **Milling with several settings**

Program(s): _____



Program layout: **Milling with several tools and settings**

Conventional preparations: *G30/G31* — Workpiece blank

Roughing

```
T . . .
G00 G40 G90 X . . . Y . . .
Z0 M3
```

Tool call
Starting position

```
G98 L 2
G91 Z-5
L 1,0
L 2, . . .
```

SPGM call

G00 Z+100 M6 — Tool exchange

Finishing

```
T . . .
G00 G40 X . . . Y . . .
Z-30 M3
```

Tool call
Starting position

```
L 1,0
```

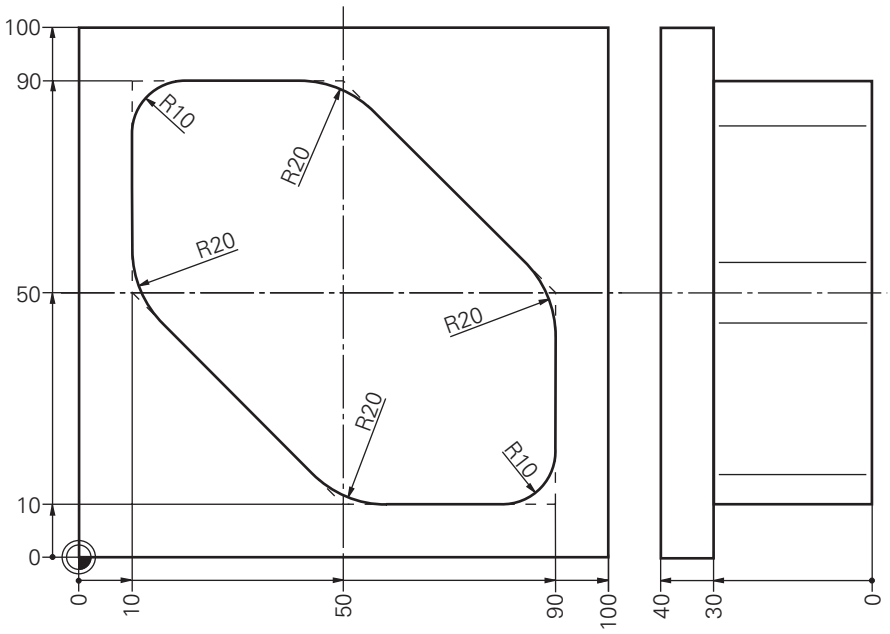
SPGM call

Retract tool, end *G00 Z100 M2*

SPGM, contour

```
G98 L 1
  •
  •
  •
  •
  •
  •
G98 L 0
```

Solution: **Milling with several settings**



MAIN PROGRAM

```
%62188 G71 *
N10  G30 G17 X+0 Y+0 Z-40 *
N20  G31 G90 X+100 Y+100 Z+0 *
N30  T13 G17 S2000 * ..... R20
N40  G00 G40 G90 Z+100 M03 *
N50  X-30Y+70* ..... AUXILIARY POINT
N60  Z+0 *

N70  G98 L2 *
N80  G01G91Z-5F200* ..... SETTING
N90  L1,0* ..... CALL CONTOUR
N100 L2,5* ..... FURTHER CONTOUR SECTIONS

N110 G00 Z+100 M06 *
N120 T14 G17 S3000 *
N130 G00 G40 G90 Z+100 M03 *
N140 X-30 Y+70 *
N150 G01 Z-30 F500 *
N160 L1,0 *
```

Retract tool, end

```
N170 G00 Z+100 M30 *
```

SPGM, contour

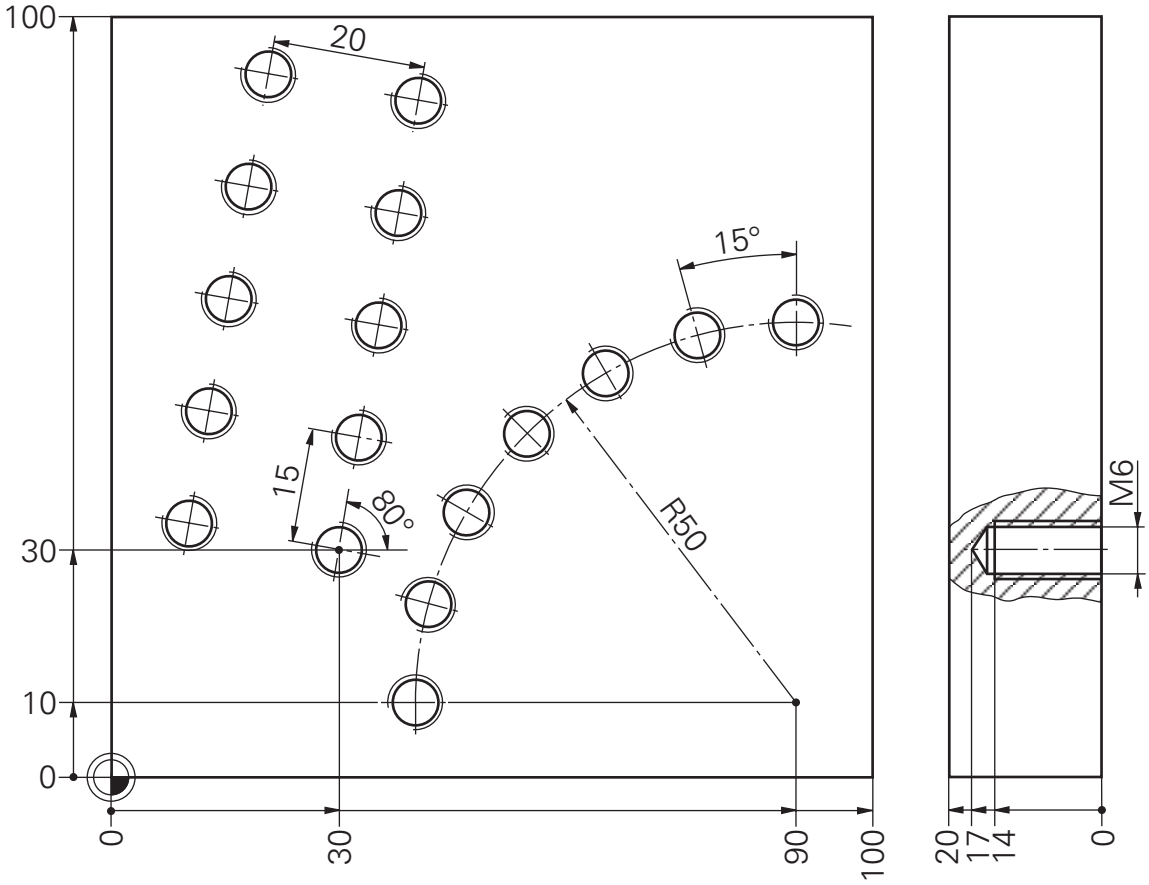
```
N180 G98 L1 *
N190 G01 G41 G90 X+10 Y+70 F200 *
N190 G26 R3 *
N200 X+10 Y+90 *
N210 G25 R10 *
N220 G01 X+50 Y+90 *
N230 G25 R20 *
N240 G01 X+90 Y+50 *
N250 G25R20* ..... CONTOUR
N260 G01 X+90 Y+10 *
N270 G25 R10 *
N280 G01 X+50 *
N290 G25 R20 *
N300 G01 X+10 Y+50 *
N310 G25 R20 *
N320 G01 Y+70 *
N330 G27 R3 *
N340 G01 G40 X-20 Y+70 *
```

SPGM end

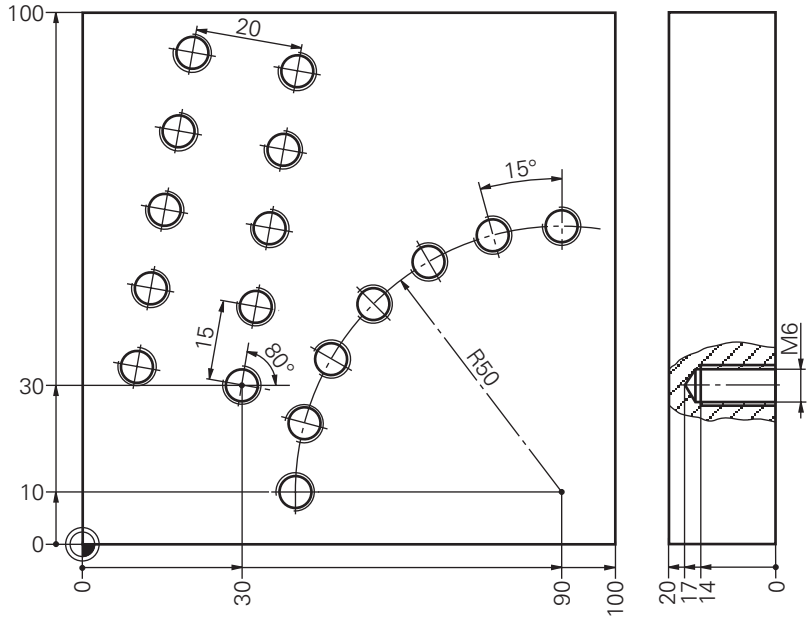
```
N350 G98 L0 *
N999999 %62188 G71 *
```

Task: **Hole pattern**

Program(s): _____



Solution: **Hole pattern**



MAIN PROGRAM

```
%62189 G71 *
N5   G30 G17 X+0 Y+0 Z-20 *
N10  G31 G90 X+100 Y+100 Z+0 *
N15  T4 G17 S1500 * ..... R2
N20  G00 G40 G90 Z+100 M03 *
N25  G200 ..... CENTER
     Q200=2 ..... SETUP CLEARANCE
     Q201=-3,5 ..... DEPTH
     Q206=150 ..... FEED RATE FOR PLUNGING
     Q202=3,5 ..... PLUNGING DEPTH
     Q210=0 ..... DWELL TIME AT TOP
     Q203=+0 ..... SURFACE COORDINATE
     Q204=2 ..... 2ND SETUP CLEARANCE
     Q211=0 * ..... DWELL TIME AT DEPTH
N30  L1,0 *
N35  L2,0 *
N40  G00 Z+100 M06 *

N45  T5 G17 S1500 * ..... R2
N50  D00 Q201 P01 -17 * ..... DEPTH
N55  D00 Q202 P01 +6 * ..... PLUNGING DEPTH
N60  G00 G40 G90 Z+100 M03 *
N65  L1,0 *
N70  L2,0 *
N75  G00 Z+100 M06 *

N80  T6 G17 S300 *
N85  G85 ..... RIGID TAPPING
     P01 2 ..... SETUP CLEARANCE
     P02 -14 ..... DEPTH
     P03 +1 * ..... PITCH
N90  G00 G40 G90 Z+100 M03 *
N95  L1,0 *
N100 L2,0 *
```

Retract tool, end

```
N105 G00 Z+100 M30 *
```

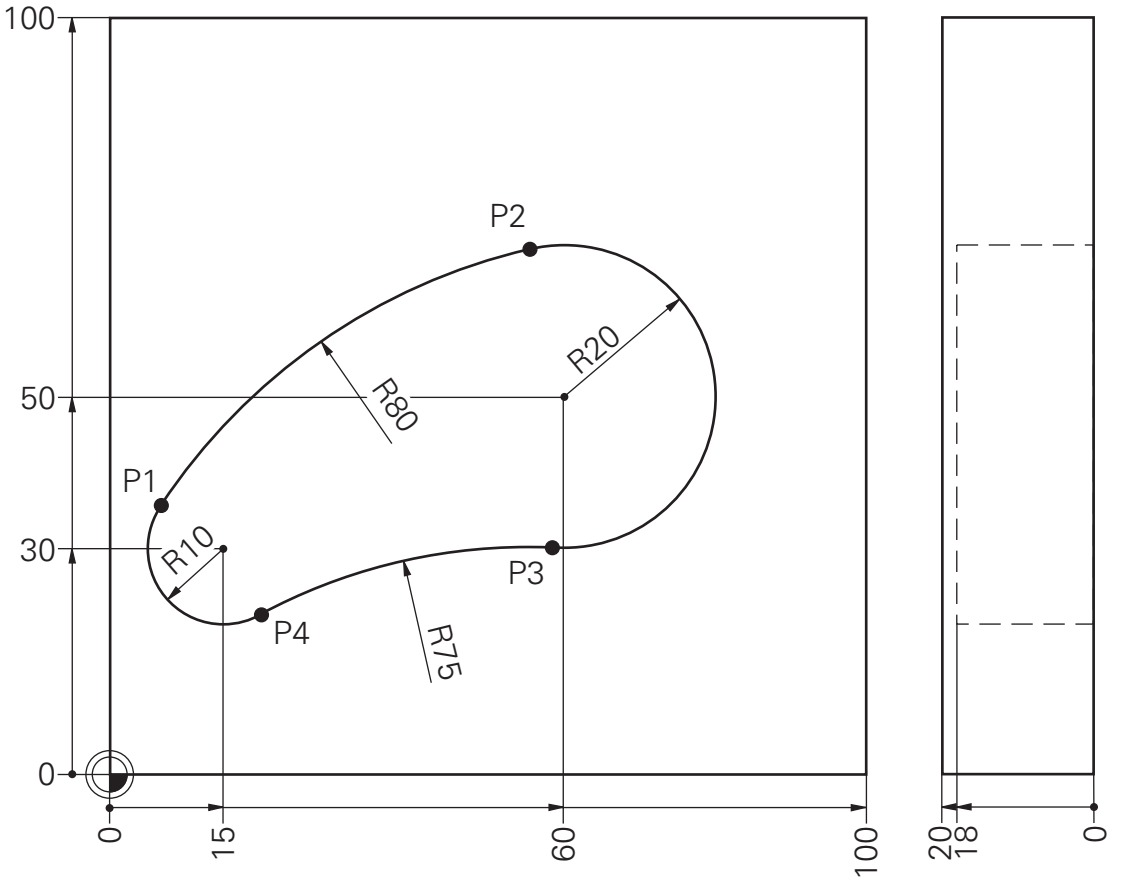
Solution: **Hole pattern**

SPGM

```
N110  G98 L1 *
N115  G220 ..... POLAR PATTERN
      Q216=+90 ..... CENTER IN 1ST AXIS
      Q217=+10 ..... CENTER IN 2ND AXIS
      Q244=100 ..... PITCH CIRCLE DIAMETER
      Q245=+90 ..... STARTING ANGLE
      Q246=+180 ..... STOPPING ANGLE
      Q247=+15 ..... STEPPING ANGLE
      Q241=7 ..... NUMBER OF REPETITIONS
      Q200=2 ..... SETUP CLEARANCE
      Q203=+0 ..... SURFACE COORDINATE
      Q204=2 ..... 2ND SETUP CLEARANCE
      Q301=1 * ..... MOVE TO CLEARANCE
N120  G98 L0 *
N125  G98 L2 *
N130  G221 ..... CARTESIAN PATTERN
      Q225=+30 ..... STARTING POINT IN 1ST AXIS
      Q226=+30 ..... STARTING POINT IN 2ND AXIS
      Q237=+15 ..... SPACING IN 1ST AXIS
      Q238=+20 ..... SPACING IN 2ND AXIS
      Q242=5 ..... NUMBER OF COLUMNS
      Q243=2 ..... NUMBER OF LINES
      Q224=+80 ..... ANGLE OF ROTATION
      Q200=2 ..... SETUP CLEARANCE
      Q203=+0 ..... SURFACE COORDINATE
      Q204=2 ..... 2ND SETUP CLEARANCE
      Q301=1 * ..... MOVE TO CLEARANCE
N135  G98 L0 *
N999999 %62189 G71 *
```

Task: **Contour cycles SL II, Roughing out kidney**

Program(s): _____

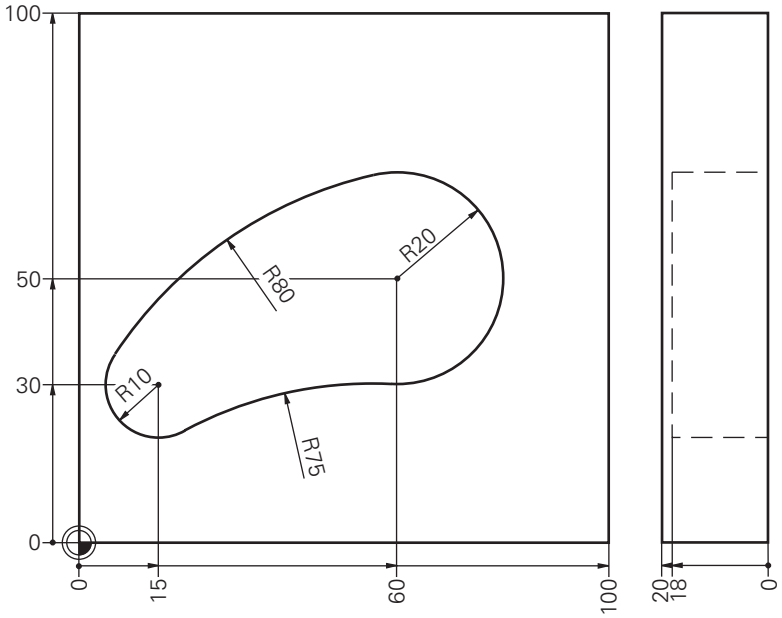


Point	X	Y
P_1	6.645	35.495
P_2	55.505	69.488

Point	X	Y
P_3	58.995	30.025
P_4	19.732	21.191

Solution:

Contour cycles SL II, Rouging out kidney



MAIN PROGRAM

```
%62190 G71 *
N5   G30 G17 X+0 Y+0 Z-20 *
N10  G31 G90 X+100 Y+100 Z+0 *
N15  T7 G17 S2500 * ..... R4
N20  G00 G40 G90 Z+100 M03 *
N25  G37 P01 1 * ..... CONTOUR
N30  G120 ..... CONTOUR DATA
     Q1=-18 ..... MILLING DEPTH
     Q2=1 ..... TOOL PATH OVERLAP
     Q3=+0,5 ..... ALLOWANCE FOR SIDE
     Q4=+0,5 ..... ALLOWANCE FOR DEPTH
     Q5=+0 ..... SURFACE COORDINATE
     Q6=+2 ..... SETUP CLEARANCE
     Q7=+10 ..... CLEARANCE HEIGHT
     Q8=+0 ..... ROUNDING RADIUS
     Q9=-1 * ..... DIRECTION OF ROTATION
N35  G122 ..... ROUGH OUT
     Q10=+10 ..... PLUNGING DEPTH
     Q11=100 ..... FEED RATE
     Q12=200 ..... FEED RATE FOR ROUGHING OUT
     Q18=0 ..... COARSE ROUGHING TOOL
     Q19=150 * ..... RECIPROCATION FEED RATE
N40  M99 *
N45  G00 Z+100 M06 *

N50  T8 G17 S2000 * ..... R5
N55  G00 G40 G90 Z+100 M03 *
N60  G123 ..... FLOOR FINISHING
     Q11=100
     Q12=200 *
N65  M99 *
N70  G124 ..... SIDE FINISHING
     Q9=-1 ..... DIRECTION OF ROTATION
     Q10=+10 ..... PLUNGING DEPTH
     Q11=100 ..... FEED RATE
     Q12=200 ..... FEED RATE FOR ROUGHING OUT
     Q14=+0 * ..... ALLOWANCE FOR SIDE
N75  M99 *
```

Retract tool, end

```
N80  G00 Z+100 M30 *
```

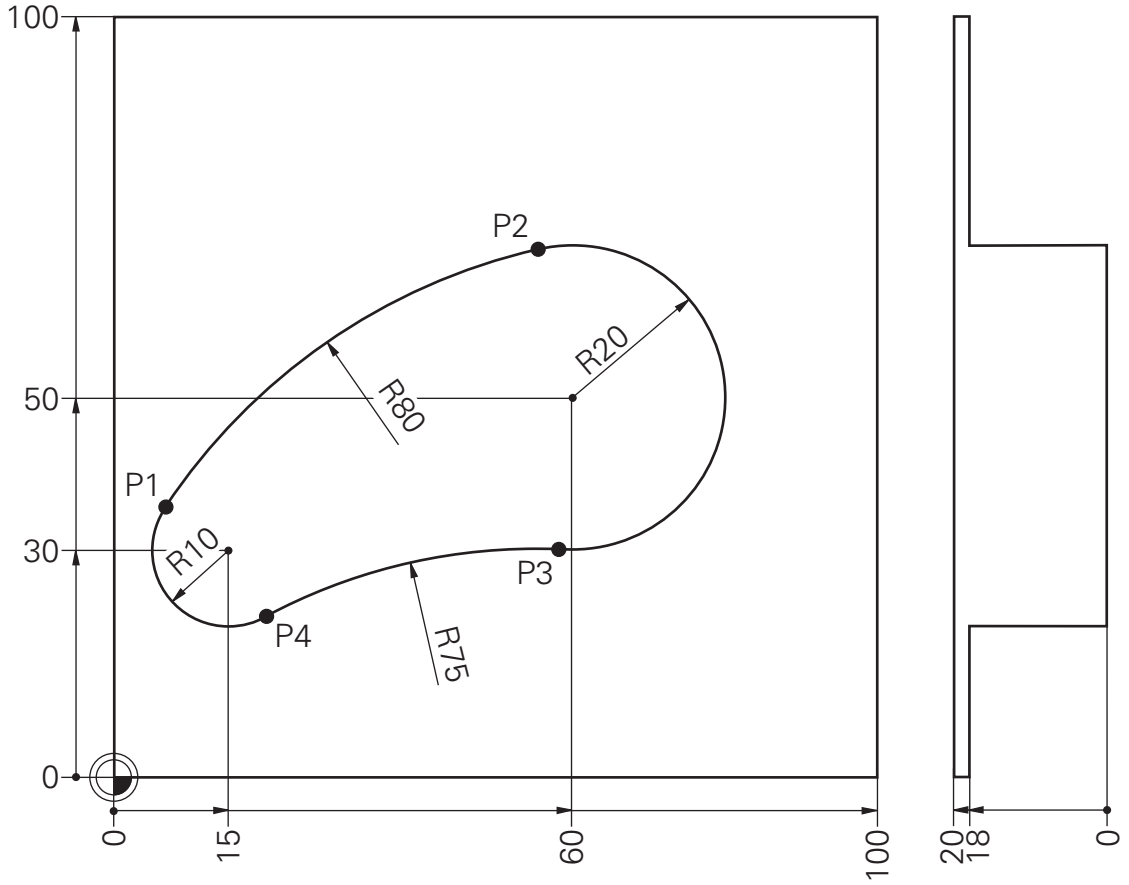
Solution: **Contour cycles SL II, Roughing out kidney**

SPGM

```
N85  G98L1*
N90  G01 G42 X+5 Y+30 *
N95  I+15 J+30 *
N100 G02 X+6,645 Y+35,495 *
N105 G06 X+55,505 Y+69,488 *
N110 G05 X+58,995 Y+30,025 R-20 *
N115 G06 X+19,732 Y+21,191 *
N120 G02 X+5 Y+30 *
N125 G98 L0 *
N999999 %62190 G71 *
```

Task: **Contour cycles SL II, Kidney-shaped island**

Program(s): _____

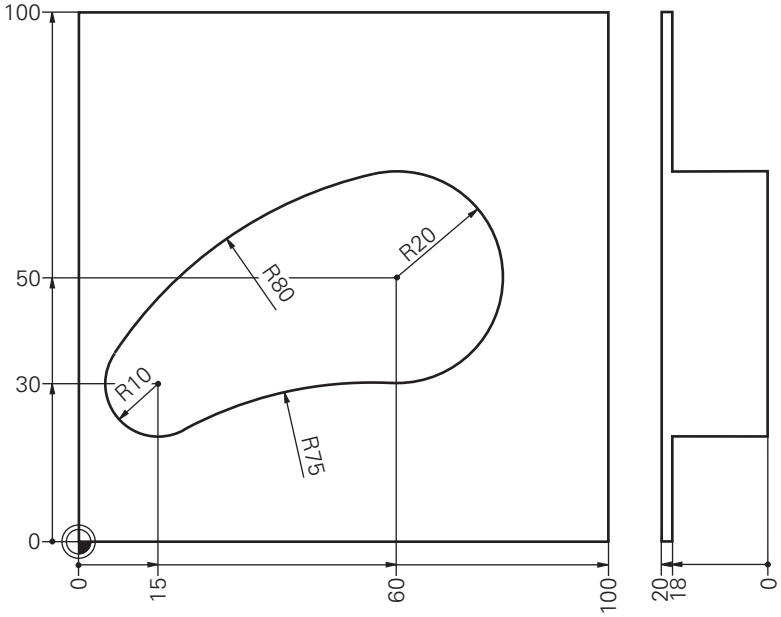


Point	X	Y
P_1	6.645	35.495
P_2	55.505	69.488

Point	X	Y
P_3	58.995	30.025
P_4	19.732	21.191

Solution:

Contour cycles SL II, Kidney-shaped island



MAIN PROGRAM

```
%62191 G71 *
N5   G30 G17 X+0 Y+0 Z-20 *
N10  G31 G90 X+100 Y+100 Z+0 *
N15  T7 G17 S2500 * ..... R3
N20  G00 G40 G90 Z+100 M03 *
N25  G37 P01 1 P02 2 * ..... CONTOURS
N30  G120 ..... CONTOUR DATA
     Q1=-18 ..... MILLING DEPTH
     Q2=1 ..... TOOL PATH OVERLAP
     Q3=+0,5 ..... ALLOWANCE FOR SIDE
     Q4=+0,5 ..... ALLOWANCE FOR DEPTH
     Q5=+0 ..... SURFACE COORDINATE
     Q6=+2 ..... CLEARANCE HEIGHT
     Q7=+10 ..... SETUP CLEARANCE
     Q8=+0 ..... ROUNDING RADIUS
     Q9=-1* ..... DIRECTION OF ROTATION
N35  G122 ..... ROUGH OUT
     Q10=+10 ..... PLUNGING DEPTH
     Q11=100 ..... FEED RATE
     Q12=200 ..... FEED RATE FOR ROUGHING OUT
     Q18=0 ..... COARSE ROUGHING TOOL
     Q19=150* ..... RECIPROCATION FEED RATE
N40  M99 *
N45  G00 Z+100 M06 *

N50  T8 G17 S2000 * ..... R4
N55  G00 G40 G90 Z+100 M03 *
N60  G123 ..... FLOOR FINISHING
     Q11=100 ..... FEED RATE
     Q12=200* ..... FEED RATE FOR ROUGHING OUT
N65  M99*
N70  G124 ..... SIDE FINISHING
     Q9=-1 ..... DIRECTION OF ROTATION
     Q10=+10 ..... PLUNGING DEPTH
     Q11=100 ..... FEED RATE
     Q12=200 ..... FEED RATE FOR ROUGHING OUT
     Q14=+0* ..... ALLOWANCE FOR SIDE
N75  M99 *
```

Retract tool, end

```
N80  G00 Z+100 M30 *
```

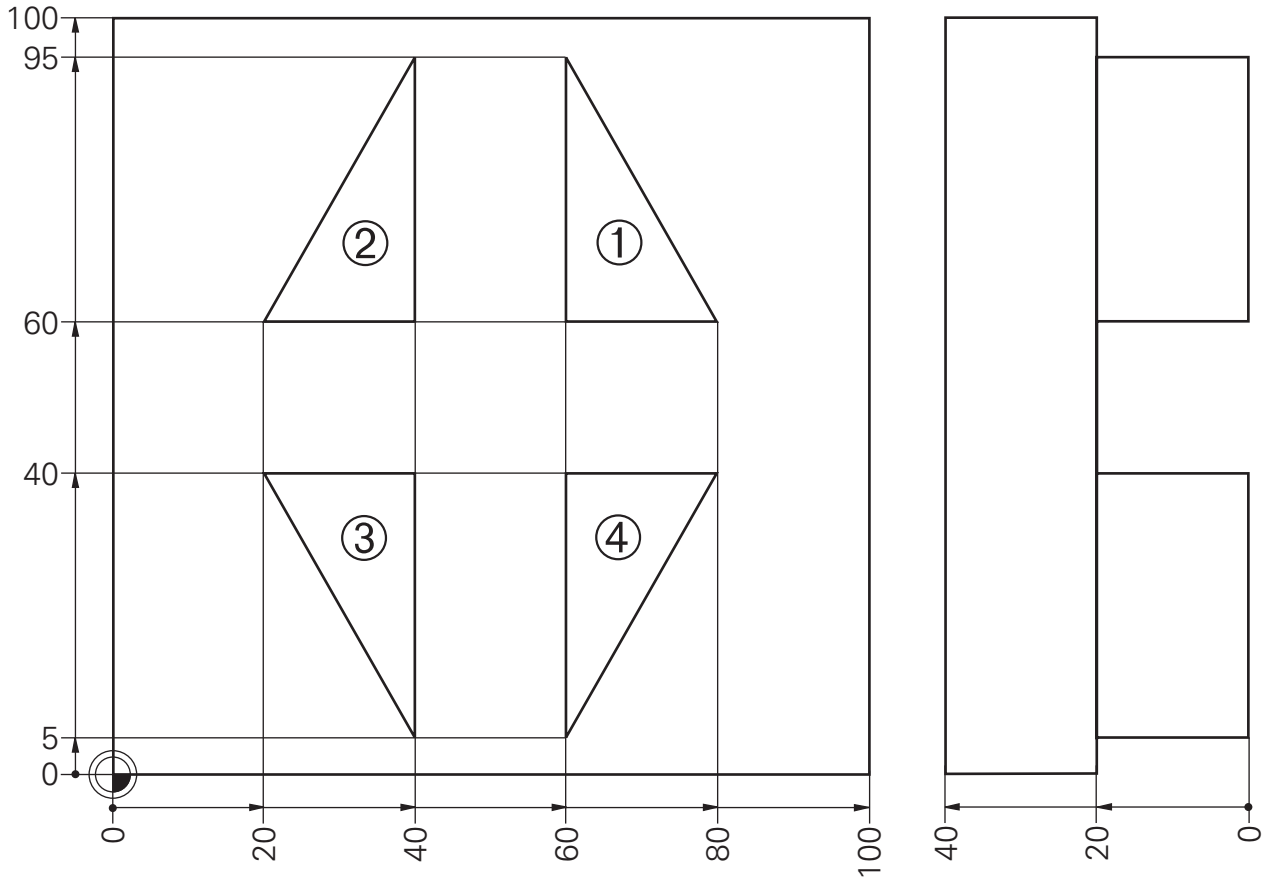
Solution: **Contour cycles SL II, Kidney-shaped island**

SPGM

```
N85  G98L1*
N90  G01 G41 X+5 Y+30 *
N95  I+15 J+30 *
N100 G02 X+6,645 Y+35,495 *
N105 G06 X+55,505 Y+69,488 *
N110 G05 X+58,995 Y+30,025 R-20 *
N115 G06 X+19,732 Y+21,191 *
N120 G02 X+5 Y+30 *
N125 G98 L0 *

N130 G98 L2 *
N135 G01 G42 X-10 Y+10 *
N140 Y+110 *
N145 X+110 *
N150 Y-10 *
N155 X-10 *
N160 G98 L0 *
N999999 %62191 G71 *
```

Task: **Datum shift and mirror images** Program(s): _____

_____



%62192 G71
⋮

Datum shift
Part ① SPGM call

Part ② Mirror images
SPGM call

Part ③ Mirror images
SPGM call

Part ④ Mirror images
SPGM call

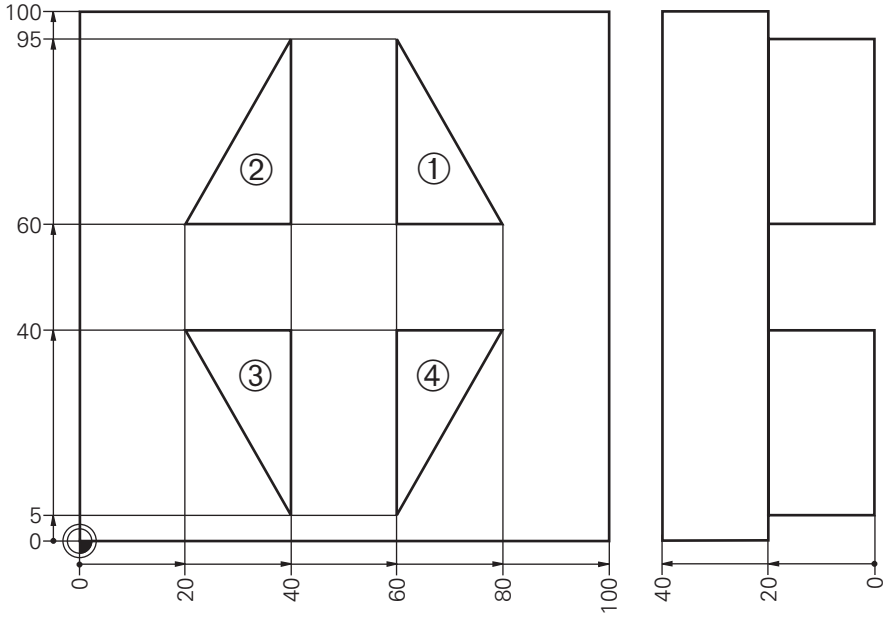
Reset cycles

Retract tool, end *G00 G40 Z +100 M2*

SPGM *G98 L . . .*

SPGM end *G98 L 0*

Solution: **Datum shift and mirror images**



MAIN PROGRAM

```
%62192 G71 *
N10  G30 G17 X+0 Y+0 Z-20 *
N20  G31 G90 X+100 Y+100 Z+0 *
N30  T7 G17 S4000 *
N40  G00 G40 G90 Z+100 M03 *
N50  G54 X+50 Y+50 *                    DATUM
N60  L1,0 *

N70  G28 X *                            MIRROR IMAGE
N80  L1,0 *

N90  G28 X Y *                          MIRROR IMAGE
N100 L1,0 *

N110 G28 Y *                            MIRROR IMAGE
N120 L1,0 *

N130 G28 *                              RESET MIRROR IMAGE
N140 G54 X+0 Y+0 *                      RESET DATUM SHIFT
```

Retract tool, end

```
N150 G00 Z+100 M30 *
```

SPGM, contour

```
N160 G98 L1 *
N170 G00 X+0 Y+0 *                      AUXILIARY POINT R0
N180 Z+2 *
N190 G01 Z-20 F200 *                    PLUNGING DEPTH
N200 G01 G41 X+10 Y+10 *                CONTOUR STARTING POINT
N200 G26 R3 *                           APPROACH TANGENTIALLY
N210 G01 Y+45 *
N220 X+30 Y+10 *
N230 X+10 *
N240 G27 R3 *                           DEPART TANGENTIALLY
N250 G01 G40 X+0 Y+0 *
N260 G98 L0 *
N999999 %62192 G71 *
```