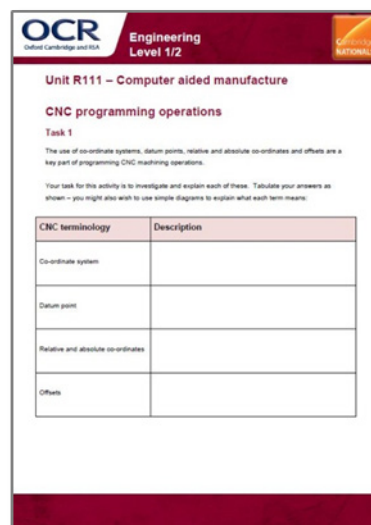# Unit R111 – Computer aided manufacture

CNC programming operations

Instructions and answers for teachers

*These instructions should accompany the OCR resource **'CNC programming operations'** activity which supports OCR Cambridge Nationals in Engineering.*

The Activity:

This resource comprises of 2 tasks.

This activity offers an opportunity for maths skills development.

Associated materials:

'CNC programming operations' activity sheet

Suggested timings:

Tasks 1 and 2: 1 hour

Learning outcome 2 – Be able to interpret information from CAD to manufacture components on CNC equipment

Task 1

This activity provides the basis for as an introduction to CNC programming. Learners might independently investigate the terminology associate with co-ordinate systems, datum points, relative and absolute co-ordinates and offsets. Teachers might alternatively introduce these concepts as part of a classroom-based activity.

Solutions to the problems are given in the following table although learners might provide more detailed or alternative solutions, and may use diagrams to illustrate their responses:

CNC terminology	Description
Co-ordinate system	The co-ordinate system is used to determine movement of the work piece and tooling in the CNC machine. For a three-axis machine these are usually labelled X, Y and Z although CNC machines may have multiple-axis movement some of which is linear and some rotational.
Datum point	A datum point is a point within the co-ordinate system which measurements and movements are taken from. In CNC machining this is often the origin point (0,0) or (0,0,0) in two and three axis systems.
Relative and absolute co-ordinates	Absolute movements in the co-ordinate system are absolute to a datum point (normally (0,0,0)). Relative co-ordinates are movements relative to the current position, for example, of the tool. Learners may use a diagram to illustrate relative and absolute co-ordinates.
Offsets	Offsets are a means of adjusting or moving the datum point within the co-ordinate system. They are often used when machining identical shapes within a work piece, for CNC machines having multiple work-holding stations, and to accommodate tool and machine wear. Learners might illustrate offsets using a simple diagram.

The following online website (CNCCookbook) provides a range of tutorials about CNC programming, and may prove a useful resource:

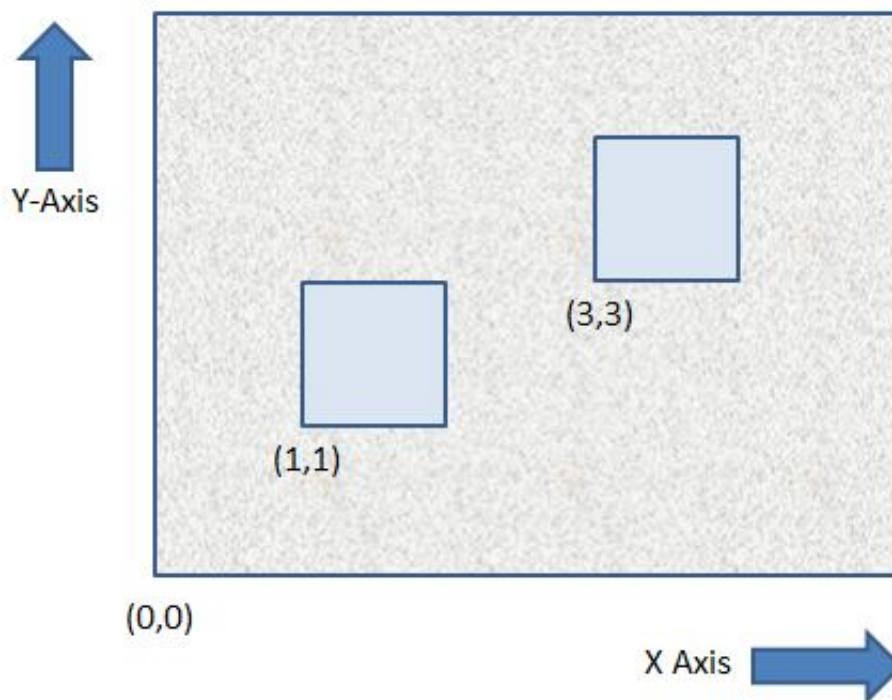http://www.cnccookbook.com/CCCNCGCodeCoordinates.htm

Task 2

In Activity 2 learners are presented with two squares to machine using a CNC milling machine. For simplicity only the X and Y axis are shown although the milling machine would also have a Z axis representing depth of cut of the milling tool.

The problem illustrates the use of co-ordinate systems, datum points, offsets and relative and absolute movement. Learners might present their solutions in G-Code with suitable teacher guidance.

Teachers might use this or another suitable example as a classroom-based activity.

Solutions

The co-ordinate system	The example shown has a simple 2-axis co-ordinate system labelled X and Y. In practice, the milling machine would also have a Z-axis.
Where the datum points are	The main datum point it at (0,0) although (1,1) and (3,3) might also be used as datum points.
How relative and absolute co-ordinates might be used to move the cutter to mill the two squares	Tool movement to each corner of both squares could be achieved using absolute or relative movement within the co-ordinate system. For the first square movement around the square (absolute) to (0,0) would be: X1Y1 X2Y1 X2Y2 X1Y2 With relative movement this would be: X1Y1 (moves tool to start point) X1 Y1 X-1 Y-1
How the use of offsets could assist with programming	Offsets could be used in the example to move the origin point to the bottom left-hand corner of each square to be machined. Typically, offsets are used where there are multiple work pieces in the CNC machine.

Learners might write simple G-Code instructions (as shown above) to illustrate their responses.

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