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COURSE TITLE: **ADDITIVE MANUFACTURING AND PRODUCTION SYSTEMS**

GUIDED BY – Prof. ALBERTO BOSCHETTO

**EXERCISE 1**

**CNC MANUAL PROGRAMMING**

**GROUP NUMBER: 10**

|  |  |
| --- | --- |
| VARUN YASHWANT RASALKAR | **1921452** |
|  |  |
|  |  |

A picture containing shape

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Diagram

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With respect to our group number the dimensions are

**R=40mm, r=2mm, α=40° and thickness t = 8mm**.

Diagram

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|  |  |
| --- | --- |
| **Work piece material** | Al7075 |
| **Chemical composition** | AlZnMgCu1.5 |
| **Strength** | High |
| **Corrosion resistance** | Average |
| **Weldability** | Poor |
| **Workability** | Poor |
| **Machinability** | Fair |
| **Density** | 2.81 g/cc |
| **Tensile Strength** | 228 MPa |
| **Yield Strength** | 103 MPa |
| **Modulus of Elasticity** | 71.7 GPa |
| **Coefficient of Thermal Expansion** | 23.4 µm/m-°C |

**Table**: Properties of the work piece material to machine.

**Usage:** As a strong, machinable aluminum alloy, it is highly used in the automotive, aircraft and aerospace industries. Highly stressed parts, such as gears, fuse parts, structural components, and bows are often comprised of 7075 aluminum alloy.

Raw material dimension: 60\*120\*8 mm^3

**Machining Technology Used**:

For machining this part, any universal milling machining is suitable and sufficient. As an exercise to choose a machine center we consider a 3 axis vertical milling machine provided by **Haas Automation, Inc** modeled as **VF-2SS**. The technical data is provided in the table below:

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**Picture**: VF-2SS by Haas Automation, Inc

|  |  |
| --- | --- |
| Max Spindle Rating | 22.4kW |
| Max Spindle Speed | 12000rpm or 15000rpm depending on upgrade |
| Spindle type | Taper CT or BT 40 |
| Rapid Feed Rates in X, Y and Z axis | 35.6 m/min |
| Max cutting feed rate | 21.2 m/min |
| Tool loading capacity | 31 |
| Max tool Diameter | 64mm |
| Cooling type | Liquid cooling |
| Coolant storage capacity | 208 liters |
| Table length\*width | 914 mm\*356 mm |
| Max weight on table | 680 kg |
| General Dimensions | 257 cm\*251 cm\*257 cm |
| Weight | 3539.00 kg |

**Table**: Specification of VF-2SS CNC milling machine by Haas Automation, Inc.

**FIXTURE USED:**

For machining this part, a horizontal type of fixture is required which could provide access to all the four sides of the raw material. So, for this purpose we considered a vacuum fixture to hold the work piece in its desired coordinates in order to machine. The general working of vacuum fixture is shown in the figure below:

diagram: working of a vacuum fixture and machining.


**Diagram:** Working of a Vacuum Fixture to hold the work piece in desired position for machining.

**Tool Systems and Process Parameters:**

The process parameters for cutting are found by these basic milling formulas given that the values of cutting speed (**Vc**) and feed per tooth (**fz**) are provided by the tool manufacturer in their tool catalogue. For this exercise the end milling tools are considered from the tool catalogue of Ubiemme Guhring Italia Srl (page no. 233, 302). The tool material considered optimal for machining Al alloys is **Solid Carbide** as per the catalogue. Two tools are considered for this part and are defined by same name, Uni-Pro End Mills (3-flutes).

UbiemmeTable

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Table: General Formulas for milling operation

Diagram

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Diagram: General dimension of an End Mill tool

|  |  |  |
| --- | --- | --- |
| **z=3** | **Tool 1** | **Tool 2** |
| Purpose | Pre machining | Slotting |
| Diameter **d1** | 8mm | 2mm |
| Cutting speed **Vc** | 350m/min | 300m/min |
| Feed per tooth **fz** | 0.057 mm/tooth | 0.019 mm/tooth |
| Total length **l1** | 63mm | 32mm |
| Effective length **l3** | 16mm | 5mm |
| Spindle speed **n** | 13926 rpm  **13900 rpm (We consider)** | 47000 rpm  **15000 rpm (We consider)** |
| Feed **Vt** | 2376.9 mm/min  **2300 mm/min (We consider)** | 855 mm/min  **850 mm/min (We Consider)** |

The dimensions of the work piece raw material are 60 mm \* 125mm\* 8 mm. The G codes and M codes can be written as:

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(PRE-MACHINING OPERATION OF THE RAW MATERIAL OF Al7075)

N010 G21 G91 G94

N020 G28 X0 Y0 Z0

N030 M06 T01 G43 H01

N040 M03 S13900 M08

N050 G00 X62.64 Y-10 Z-8

N060 G01 Y128 F2300

N070 G03 X-48 Y-32 R40

N080 G02 X-20.642 Y-32.47 R40

N090 G91 G01 X62.6421 Y-55.528 Q320

N100 G49 G00 X00 Y00 Z00

(CHANGING TOOL FOR MAKING THE SLOT)

N110 G91 M06 T02 G43 H02

N120 G28 X0 Y0 Z0

N130 G00 X60 Y38

N140 M03 S15000 M08 G00 Z-4

N150 G01 X-23.36 F850

N160 G02 Y2 R1 Q180

N170 G01 X24

N180 G00 Z-4

N190 G01 X-24

N200 G03 Y-2 R1

N210 G01 X24

N220 G00 Z5

N230 G49 G00 X0 Y0 Z0 M09 M02 M30

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