MAT^2 CNC Courses By School Period

Year One

School Period 1   Interpreting Blue Print

Machine Tool Processes I

Work Place Safety / OSHA 10

School Period 2   Introduction to CNC

Fundamentals of Machine Tools

Introduction to Industrial Drafting

School Period 3   Fundamental Concepts of GD&T

Introduction to CAD

Shop Math

Gen ED

School Period 4   Advanced Machine Tool Operations

CNC Operations

Gen ED

Year Two

School Period 5   Surface Footage / Material Fundamentals

Machine Tools III

Gen ED

School Period 6   Material Fundamentals

Advance CAM

SolidWorks

School Period 7   Gen ED

CAD/CAM

Gen ED

MACROS Training

Year Three

School Period 8   Multi Axis CNC Programming

Gen ED

Gen ED

Technical Elective

School Period 9   Advanced CNC Operations

Gen ED

MAT2 CNC DACUM (Learning Objectives)

I. Operator   1.0 Work Place Safety

1.1   Cleanliness, PPE's (per company policies), lock-out-tag (LOTO), hazardous materials (flammable; extinguisher to use for different types of fires), understand the functions of safety guards, multitasking (phone use), environmental issues

1.1A   Apply proper lock-out-tag procedures during machine maintenance

1.1B   Identify which fire extinguisher to use to suppress different types of fires

1.1C   Demonstrate appropriate focus when operating machinery (avoiding unnecessary distractions)

1.1D   Demonstrate cleanliness in personal and machine work areas

1.1E   Understand function of safety guards

1.1F   Disposes waste materials – both liquids and solids according to accepted environmentally safe practices

1.1G   Adhering to given PPE requirements

2.0 Metrology Equipment

2.1 Non-digital Micrometer (metric & standard), non-digital caliper, indicator, scale, bore gauges, gauge blocks, gauge pins, precision straight edge, thread gauge (ID & OD), sine bar, thread wires, sine vise, height gauge, optical comparator, shadow graph, CMM (intro)

2.1A Able to correctly use metrology equipment, including non-digital Micrometer (metric & standard), non-digital caliper, indicator, scale, bore gauges, gauge blocks, gauge pins, precision straight edge, thread gauge (ID & OD), sine bar, thread wires, sine vise, height gauge, optical comparator, shadow graph, CMM (intro)

3.0 Basic Manual Machine Tool Knowledge

3.1 Nomenclature, functions, (drill press, surface grinder, mill, lathe, ped. Grinder, sanders, id/od grinder, cut off saw (vert/horiz), hand tools

3.1A Correctly identity **nomenclature** and components of the following machine tools: drill press, surface grinder, mill, lathe, ped. Grinder, sanders, ID/OD grinder, cut off saw (vert/horiz)

4.0 Shop Math

4.1 Add/Subtract (fractions & dec.), Metric Conversion, Geometry, Right Angle Trig.

4.1A Demonstrate accurate basic math functions (add, subtract, multiply, divide)

4.1B Demonstrate ability to use basic math functions with fractions and correct decimal placement

4.1C Demonstrate ability to convert inches to metric measurement system

4.1D Apply plane geometry principles to calculate machining points

4.1E Apply right angle trigonometry to calculate machining points

5.0 Tool Knowledge

5.1 Wear, Types, Life, Tool Geom, Materials, Properties of Metal, how to handle, Insert Nomenclature

5.1A Identify types of tools used in machining

5.1B Identify tool wear that impacts dimensional integrity

5.1C Recognize tool life expectancy

5.1D Identify tool geometry as it relates to part geometry

5.1E Correlate tool material with part material

5.1F Recognize and recall metal alloy properties

5.1G Demonstrate appropriate handling techniques for both carbide and high-speed steel tools

5.1H Correctly identify "insert angle", "radius", "IC", "positive/negative rake angles"

6.0 Cuts Raw Stock

6.1 How to use a saw, blade selection, and raw length v. finished, raw v. finished diameter, selection of appropriate stock, material marking & traceability

6.1A Given a specific material, demonstrate the ability to select and safely mount the correct saw blade for the application

6.1B Identify the difference between raw length & diameter and finished length & diameter of a part

6.1C Select appropriate stock based on given specifications

6.1D Using SOP remark stock to indicate type of material

7.0 Raw & Finished Material Handling

7.1 Protection of materials and finished parts, proper packaging for finished parts, proper deburring methods, identify materials using various color coding systems, understanding routing & tagging

7.1A Protect finished parts and raw material using SOP

7.1B Demonstrates proper and safe deburring methods

7.1C Identify materials using various color coding systems

7.1D Understands common routing and tagging procedures

8.0 Fundamental Concepts of GD&T

8.1 Symbols, interpretations, applications / measurement of part features

8.1A Understands concepts of GD&T including symbols, interpretations and applications

8.1B Able to measure part features

9.0 CNC Machine Start-up

9.1 Power up & down procedure, program verification, tool verification

9.1A Uses SOP to power up and power down CNC machines

9.1B Given set-up instructions, can identify the correct program and associated tools for that program

10.0 Basic Programs / Graphical Output

10.1 Tool path in graphics, Basic GM Code, Program ID, recognition, program & tool verification

10.1A Read basic GM code

10.1B Recognize program

10.1C Able to verify if programs and tools are correct for a given job

10.1D Recognize tool path in graphical output

11.0 Basic Tool Usage

11.1 Hand tools: File, Punch, Allen Wrench, Adjustable Wrench, Torx, Deburring tool, Torque wrenches, bearing pullers, dead blow hammers, air tools, etc.

11.1A Demonstrate proper use of hand tools including: File, Punch, Allen Wrench, Adjustable Wrench, Torx, Deburring tool, Torque wrenches, bearing pullers, dead blow hammers, air tools, etc.

12.0 Part Inspection

12.1 Measuring: ODs, IDs squareness, angles, flatness, parallelism, concentricity, threads, perpendicularity, surface finish, recording & reporting quality & compliance and non-compliance inspection data, SPC (Cale – CPK, Gauge R&R)

12.1A Able to inspect parts using the following criteria: ODs, squareness, angles, flatness, parallelism, concentricity, threads, perpendicularity, surface finish, Gauge R&R

12.1B Record and report quality and compliance and non-compliance inspection data, SPC (Cale –CPK, Gauge and R&R)

13.0 Material Fundamentals

13.1 Traceability, tensile strengths, quenching, annealing, normalizing, stress releasing, anodizing, material condition, hard coating, plating, hardness testing, standard numbering system for material

13.1A Recognize standard material numbering system

13.1B Understand material characteristics including: traceability, tensile strengths, quenching, annealing, normalizing, stress relieving, anodizing, material condition, hard coating, plating, hardness testing

14.0 Interprets Blueprints

14.1 Identification of angle projection, revision levels, Recognition of title block information, bill of materials, notes section, basic blueprint reading skills

14.1A Read basic blueprint features, such as title block, bill of materials and notes section

14.1B Identify angle projection and revision levels

15.0 Tool Identification for Cutting

15.1 Identification of right hand/left hand, positive/negative, understanding tool type, tooling geometry, cutting radius, tool nose radius, drilling, milling, and turning, grinding

15.1A Understand tool types and associated geometry

15.1B Match tool type to the appropriate application, ie., drilling, milling, turning or grinding

15.1C Identify right hand/left hand, positive/negative

15.1D Understand cutting radius and tool nose radius

16.0 Tooling Definitions & Selection

16.1 Material requirement, surface finish, rough cutting v. finish cutting

16.1A Select the proper cutting tool for material removal based on the metallurgy 16.1B Select the proper cutting tools for both rough and finish material removal 16.1C Select the proper cutting tool based on blueprint surface finish requirements

17.0 Surface Footage

17.1 Calculations, reading manufacturing charts, reading feed/speed slide rule, feed & speed formulas

7.1A Calculate surface footage

17.1B Read manufacturing charts

17.1C Read feed/speed slide rules

17.1D Calculate feed/speed formulas

18.0 Machine Offsets & Compensation Settings

8.1 Setting origin, read, modify, and comp offsets, additive offsets, understand work shift, offset management

8.1A Able to discriminate between machine zero and part zero

18.1B Demonstrates the ability to origin-out all programmable axes

18.1C Demonstrates the ability to find, understand and modify work and tool off-sets

19.0 Daily Machine Maintenance

19.1 Lube oil (checking levels), greasing chuck, coolant levels & concentration (how to use/read a refractometer, machine cleaning (standards), check machine calibration

19.1A Checks level of lubricants and coolants prior to operating machinery 19.1B Given SOP, greases chucks when indicated

19.1C Checks concentration of coolants using a refractometer

19.1D Given SOP, cleans machinery

20.0 Part Loading

20.1 Clean fixture, Solid Stops, clamping, proper torque, deburring, using appropriate PPE

20.1A Ensure that fixtures are clean when loading parts

20.1B Demonstrate proper solid stops procedures

20.1C Demonstrate proper clamping techniques

20.1D Ensure correct torque

20.1E Able to deburr finished parts

21.0 Tool Change/Replace

21.1 Clean tool pocket, qualify tool (setting & activating the offsets), R&R replacement procedures, check for run out

21.1A Set and activate tool offsets (qualify tool) 21.1B Clean tool pocket

21.1C Correctly apply replacement procedures (R&R)

21.1D Check for run out

22.0 Basic CAD

22.1 2D drawing and dimensioning, file formats, DXF, IGES, etc.…

22.1A Demonstrates proficiency in development of 2-D drawings using right-angle projection and accepted industrial dimensioning standards

2.1B Use correct file storage format for intended CAD application

22.1C Demonstrates proficiency in translation of 2-D drawings into DXS, IGES, etc. formats

23.0 Process Control Plans

23.1 Knowing & following Process Planning steps to SOP

23.1A Use SOP to follow necessary process planning steps to achieve project specifications, quality and delivery

24.0 Job Planning Flow

24.1 Routing jobs, First Part Prove out CNC Procedures

24.1A Able to conduct first part prove-out CNC procedures

24.1B Able to correctly route jobs

25.0 Job Planning Flow

25.1 Lean Manufacturing Principles, labeling, 5 S Knowledge (Housekeeping System in a Plant), separate tools from measurement equipment ('kitting'), cleanliness 25.1A Describe Lean Manufacturing Principles

25.1B Apply Lean Manufacturing Principles

25.1C Practice workplace organization and cleanliness based on given SOP

25.1D Able to correctly discriminate between hand tools and measurement tools

26.0 Critical Thinking Skills

26.1 When to ask v. when to act, problem solving/ troubleshooting (how to read a flowchart), intro to FMEA concept

26.1A Demonstrate ability to use a flowchart to diagnose or trouble shoot problems

26.1B Recognize when to ask for help versus when to act on own initiative

27.0 Time Management Skills

27.1 '15 minutes prior to 15 minutes prior' (be on time), sense of urgency, productivity, self-directed, grouping tasks (matrix), value of time (production/quality), do it right the first time, focus

27.1A Understand and use a time and priority management tool (i.e. Eisenhower Matrix) to organize work and maximize productivity

27.1B Apply time management skills to expected work habits, including arriving early for work, focusing on tasks, having a sense of urgency, completing tasks correctly the first time, grouping tasks for maximum efficiency

28.0 Communication Skills

28.1 Peer training, English v. Technical Language, shift hand off- logging status (describe oral/written) status of job, issues, new progress), how to ask questions, team building (open to other opinions, come up with solutions as a group, respectful of different approaches, presentation skills) technical writing, how to construct an email (re-read), context v. content (non-verbal), relationship building

28.1A can identify and correctly apply open, closed, alternative and leading questions

28.1B Recognize the difference between content and context in communication

28.1C Constructs written communication (emails, reports, shift hand-off status reports) using correct sentence structure, punctuation, and technical terminology

28.1D Uses questioning and listening skills to encourage team involvement and collaboration

28.1E Double checks written communication by using editing techniques, such as re-reading or reading backwards

28.1F Able to present clear and logical project information to peers, management or other stakeholders

29.0 Holding Device Selection

29.1 Identify and use: vise, manual, hydraulic, pneumatic clamps fixtures (different classifications)

9.1A Identify and use the following holding devices: Vise, manual, hydraulic, pneumatic clamps fixtures various classifications

30.0 Machine Set-up

30.1 Indicate fixtures to find work co-ordinates, jaw prep, cleanliness, know more about, vise and chuck alignment, operations of the machine (MDI transformations)

30.1A Indicate fixtures to find work co-ordinates

30.1B Prepare jaws if necessary to vise to receive stock

30.1C Unilize MDI function during set up of machine

30.1D Ensure machine cleanliness

30.1E Ensure vise and chuck alignment

31.0 Tool Offsets

31.1 Apply offset methods including manual, automatic, set up tool life management

31.1A Apply both manual and automatic tool offset methods

32.0 Work Offsets

32.1 Manual, automatic probing, and modification

32.1A Apply both manual and automatic tool probing methods to determine work offsets, or modify if necessary

33.0 Parts Inspection Methods

33.1 Run, verify, analyze machine's report, inspecting part geometry, First Piece of Confirmed Quality, and adjust program and tooling based on CMM report

33.1A Inspect part quality by using given data to analyze and verify given specifications

33.1B Use report data to adjust program and tooling based on CMM report

33.1C Understand the concept of "first piece of confirmed quality" or "first artifact" and how it impacts production

34.0 Tool Selection and Use

34.1 Understanding of tool selection for the specific job being run

34.1A Select correct tool for job

35.0 Job Set-up

35.1 Be able to read and setup a job based on the specifications provided (Setup & Follow-up Sheets), ability to setup non-standard tools

35.1A Read and setup a job based on the specifications provided (Setup & Follow-up Sheets)

35.1B Setup non-standard tools

36.0 CNC Machine Tool Manual Operation

36.1 Jogging and part orientation, part indication, verify against tool placement charts, verify tool, loading tools in to carousel, conduct dry run, hand off to operator

36.1A Perform manual CNC machine tool operations including jogging and part orientation, part indication

36.1B Verify tools against tool placement charts

37.0 Machine Mechanics/Capabilities

37.1 Drives/ Hydraulics, pneumatics, etc., able to identify number of axes, machine capability due to size and type of material, rev limits of the machine itself, dry run, low feed override, low rapid override

37.1A Identify number of axes, machine capability due to size and type of material and rev limits of the machine itself

37.1B Understand the application differences between hydraulics, pneumatics and other types of drive systems

37.1C Able to perform a dry run

37.1D Able to adjust feed rate and speed using machine controls

38.0 Tool Life Management

38.1 Use tool life data to control tool life and quality of part produced

38.1A Understand how tool life affects the quality of parts produced

38.1B Utilize tool life data to predict the number of parts that can be run for a given tool

39.0 Work Shift Coordination System

39.1 Setup Pallet Changer, G54, G55, G56, etc., absolute- incremental, transformation

39.1A Utilize work offsets G54, G55, G56, etc., to set up pallet changer using either absolute or incremental programming methods

40.0 Job Validation

40.1 Validate: revision levels, part numbers, program levels and Verify program, print, and route

40.1A Awareness of job validation using the following criteria: revision levels, part numbers and program levels.

40.1B Aware of verifying job program, print, and route specifications

41.0 Read and Interpret CNC Programs

41.1 M&G programming, sub routines, I,J,K, circular interpolation, canned cycles, cutter compensation, understand proper startup commands, proper ending commands, along with sub programs, word address format

41.1A Recognize the following CNC program terminology: G&M word address programming format, sub routines, ie., I,J,K, circular interpolation, canned cycles, cutter compensation

41.1B Understand proper startup and ending commands, along with sub programs

42.0 Process Flow

42.1 Concept of internal customers (provide what colleagues need), understanding the urgency of start date/due date to determine next job/steps and the impact of setup role, how to present process improvements

42.1A Understand the concept of internal customers and apply by providing what colleagues need

42.1B Understand the urgency of start date/due date to determine next job/steps 42.1C Understand how the setup role impacts shop process flow

42.1D Present process improvements to project stakeholders

43.0 Productivity (Time Management)

43.1 Grouping setups (similar jobs) to save time, understanding concept of throughput, managing the 'bottlenecks', theory of constraints, production time reduction, read & use initial data to modify program for time savings

43.1A Strive to reduce production time by application of throughput, bottlenecks, theory of constraints

43.1B Read and use initial data to modify program to achieve time savings

43.1C Group setups (similar jobs) to save time

44.0 Active NC System Data Management

44.1 Load part program, tool offsets and geometry, variables, FIS into the machine

44.1A Load part program, tool offsets and geometry and other common variables into the CNC machine

45.0 Intro to CAD / CAM

45.1 2D, intro to CAD CAM

45.1A Utilize data from 2D CAD drawings, to generate CNC programs using a CAD/DAM system

46.0 Conversational Programming

46.1 Know what it is

46.1A Recognize the concept of conversational programming

47.0 Training CNC Operators

47.1 Demonstrate CNC operator tasks at 100% proficiency, ("tell, show, do"), understand learning objective and organize the data to meet objective, remediate & validate learning

47.1A Demonstrate CNC operator tasks at 100% proficiency,

47.1B Understand learning objectives and organize the data to meet objectives (using skill building model of "tell, show, do")

47.1C Remediate & validate learning

48.0 Communication

48.1 Use proper English (spelling, speaking) at all levels (peers, mgmt., subs), technical and persuasive writing skills

48.1A Uses correct grammar in both written and oral communication with all levels (peers,

48.1B Demonstrates both technical and persuasive writing skills

49.0 Cycle Time Reduction

49.1 Focus on efficiency, recognizing air time, editing feeds & speeds, reducing/ eliminating redundant tool change, tool change position, depth of cut, validation of program through graphical rep., Write Programs & Optimize CNC Program to Reduce Cycle Time

49.1A Facilitate part production time by recognizing tool air time along with enhancing feed and speed rates of the cutting tool.

49.1B Recognize and change redundant tool applications to reduce part machine time

49.1C Using the machines graphical tool path generation, reduce production time by editing appropriate program code to reduce cycle time

50.0 Process Selection

50.1 Based on part specification & machine/equipment capability, shop capacity, create setup sheets tool extensions, etc.

50.1A Select appropriate CNC process, based on part specification and machine/equipment capability and shop capacity

50.1B Create setup sheets, tool extensions, etc.

51.0 Work Holding Selection

51.1 Building/selecting work fixtures, troubleshoot, utilize CAD System, and utilize universal tooling (when available)

51.1A Select work holding devices for parts to be produced

51.1B Design ficture for parts that will not utilize standard work holding devices utilizing a CAD system and use standard tooling for machining purposes

52.0 Writing Sub Routines

52.1 Incremental/Absolute, looping, polar co-ordinates, nesting, knowing when to use v. not use subroutines

52.1A Using Absolute or Incremental programming write subroutines

52.1B Using subroutine calls be able to loop them as to cause the sub routine to repeat itself

52.1C Determine the proper application of subroutines in a program

53.0 Proper Tool Selections

53.1 Select cutting tool based on material (i.e. aluminum v. steel, etc.) and operation features of the part, know what tools are needed for application

53.1A Based on material selection for part production select the correct tools (Material) and the correct tool geometry for the material removal process.

54.0 Troubleshooting

54.1 CNC Issue, problem solving (logic), use various problem solving tools (i.e the '5 Whys', flowcharts, FMEA, etc.)

54.1A Use various problem solving tools, (i.e., "5-Whys", diagnostic flowcharts, FMEA)

54.1B Apply problem solving logic to resolve CNC machining errors, improve cycle time or other desired outcomes

54.1 C Understand FMEA (Failure Mode Effects Analysis)

55.0 CAD/CAM

55.1 Multi-axes, 3D data input and produce

55.1A Develop full scale solid models that represent the multi-axis part to be produced.

56.0 File Management

56.1 Understanding File Transfer and Process (DNC or Trickle Feed): How and when to use it, how to restart when there's an interruption, file updating

56.1A Determine which program file input method to use

56.1B Using SOP input part program into the controller

56.1C Restart program correctly due to interruption

56.1D Use a program comparing software, compare original program with edited one

57.0 CMM Operation

57.1 Know what it is, when to use, and operate effectively

57.1A Determine if CMM should be used to inspect the part based on print specifications and operate it correctly

58.0 Company Metrics

58.1 Understand: On time delivery, efficiency, productivity, effectiveness, overhead cost, cost per hour, absorption, OEE, quality, safety

58.1A Understand the role of the metrics in measuring company performance

58.1B Able to identify and differentiate between efficiency, effectiveness, and productivity

58.1C Able to interpret key financial indicators including- overhead cost, cost per hour, and absorption

59.0 Project Leadership and Management

59.1 Works well with the team, good listening skills, understand the end goal, offer to help problem solve, understand inputs & outputs, interact with engineering & MGT, recognize potential problems (forward thinking), report writing, Work List Priority, Planning Capacity

59.1A Listen to project stakeholders

59.1B Offer ideas and potential solutions in meetings

59.1C Interact with engineering, management and other project stakeholders

59.1D Anticipate potential problems

59.1E Prioritize work tasks

59.1F Understand capacity planning

59.1G Maintain focus on end goal(s)

60.0 Macro Programs

60.1 Accurately perform a macro program, when to use v. when to not use, math skills, repeatable, good editing skills (avoid human error), know variable table

60.1A Understand and demonstrate when to use Macros for producing parts and how the variable tables will affect how the Macro preforms

61.0 Training

61.1 Ability to: train setup person and to perform full job, create a training plan, min. down flow, be aware of the initial learning process

61.1A Train operators and set up personnel

61.1B Create training plan based on desired skills and learner readiness

61.1C Factor in production schedule to accomplish training with minimal impact on shop output