

**BETHLEHEM AREA VOCATIONAL-TECHNICAL  
SCHOOL  
3300 CHESTER AVENUE BETHLEHEM PA 18020**



**Industrial Design/Advanced Manufacturing**  
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## **Industrial Design/Advanced Manufacturing**

### **Course Description:**

The industrial design and advanced manufacturing program at Bethlehem Area vocational-technical School is a 3 year program. In the first year students learn the basics of manual machining, implement all aspects of safety, blueprint reading as well as entry level CNC programming.

Students in the advanced section of the course learn Advanced CNC programming, 3D printing and focus more on extreme precision using all manual equipment. Our attention is focused on NIMS projects as midterm and final projects each year. Students will complete a senior project before graduating that consists of innovating and inventing.

Possible career paths include: Machinists, tool and die makers, CNC programmers, CNC operators, tooling designers, mechanical engineers.

**Average pay:** According to Payscale.com, the average salary for these occupations range from 35K to 100K

**Two-Year Degree Possibilities:** Associate's in Machine Tool Technology

## **Reference Material:**

American Machinist  
PayScale. Com  
Tooling U  
Machinery's Handbook  
NIMS.com

## **Classroom Tools:**

**8 Clausing Lathes**

**8 Sharp Bridgeport Milling Machines**

**2 Haas CNC Mini Mills with tool changing capabilities**

**1 Haas CNC Lathe**

**1 Trac Lathe**

**1 Trac Milling Machine**

**Dayton Vertical Band Saw**

**Dayton Horizontal Band Saw**

**2 Clausing Surface Grinders**

**1 Tool and Cutter Grinder**

**2 Makerbot 3D Printers**

**12 Station Computer Lab with 2 Haas CNC test units**

**Text Book:**

**Precision Machining Technology 2nd Edition**

**WorkBooks:**

**-Precision Machining Technology 2nd Edition**

**-Mathematics for Machining Technology 7th Edition**

# Course Syllabus Level 1

## First Semester (First Marking Period)

### Career Exploration: Rotation

#### Projects:

Dice project

Turner's Cube

CNC keychain

3D print project with Thingiverse.com

#### Duty and Tasks Covered:

##### 400 Benchwork

401 Demonstrate safety procedures while doing bench work

403 File 2 specifications

410 Identify and use bench tools

##### 500 Drill presses

501 Drill Press-identify primary machine components

503 Demonstrate safety precautions when using the drill press

504 Demonstrate the use of drilling machines

507 Demonstrate the use of Center drills

**Career Exploration Outcomes:** Students can make an informed decision regarding if the Industrial Design and Advanced Manufacturing program is of interest to them.

## **First Semester (Second Marking Period)**

**Drill grinding gage**

**C-Clamp**

**Tap guide block**

**1 2 3 blocks**

### **Duty and Tasks Covered:**

#### **300 Part inspection**

301 Identify care and use of Precision measuring instruments

#### **400 Benchwork**

402 Cut material with a hand hacksaw

404 Cut threads with hand taps and dies

#### **500 Drill presses**

505 Calculate speeds and feeds

506 Select and change tool holding devices

507 Demonstrate the use of Center drills

511 Pre drill and tap holes

515 Select and demonstrate proper use of work holding devices

#### **600 Operate grinding machines**

601 Demonstrate knowledge an application of OSHA safety rules using pedestal and surface grinding machines

602 Identify parts of a pedestal grinder

#### **900 Power saw**

901 Identify and demonstrate safety procedures for using vertical and horizontal band saws

## **Second Semester (Third Marking Period)**

### **Projects**

**\*NIMS\***

**-Benchwork and layout**

**V-block Set**

**C-clamp screw**

**Parallel Set**

**Hammer Handle**

### **Duty and Tasks Covered:**

#### **400 Benchwork**

409 Assemble and disassemble parts

411 Identify and use a hand Arbor and or hydraulic press

#### **500 Drill presses**

508 Select correct drill sizes for various applications

509 Pre-drill and ream various hole sizes

510 Demonstrate counterboring, spot facing, and countersinking

#### **600 Operate Grinding Machines**

604 Demonstrate the proper way to test, mount, and dress grinding wheels

605 Grind and sharpen various lathe tools

#### **700 Operating Lathes**

701 Identify and demonstrate lathe safety procedures

702 Mount and true workpiece in 3 and 4 jaw chucks

703 Align centers

704 Face workpiece

705 Turn outside diameters

715 Demonstrate filing and polishing

718 Demonstrate various tool holders and their correct use

722 Demonstrate use of a collet attachment

## **800 Milling machines**

- 801 Identify and demonstrate safety procedures for using a milling machine
- 802 Demonstrate tramming of head
- 803 Select mount and indicate vise
- 809 Select and demonstrate the use of face mills

## **1000 Maintaining machines and tools**

- 1001 Demonstrate proper lubrication and maintenance of machinery
- 1003 Clean and store hand tools, cutters, fixtures and attachments

## **1200 Use of charts and references**

- 1201 Use the numeric decimal equivalent chart
- 1202 Use speed and feed charts

## **1300 Blueprint Reading**

- 1302 Identify and explain orthographic views and projections
- 1303 Demonstrate basic sketching and dimensioning

## **1400 CNC Programming**

- 1401 Identify and explain fundamental CNC terminology
- 1403 Demonstrate basic use of G & M codes
- 1405 Identify and demonstrate the use of cartesian and polar coordinate systems

## **Second Semester (Fourth Marking Period)**

### **Projects:**

NIMS Drill Press  
Vise Body  
Vise moveable jaw  
Vise Screw  
CNC Practice part  
Parallel Clamp

### **Duty and Tasks Covered:**

#### **600 Operate Grinding Machines**

607 Grind 30 degree external and internal threading tools  
609 Identify and demonstrate surface grinding safety procedures  
610 Identify parts of a surface grinder

#### **700 Operating Lathes**

709 Demonstrate knurling  
710 Part off and groove workpiece  
711 Cut external threads using a single point tool

#### **800 Operate Milling Machines**

811 Demonstrate use of digital readout  
812 Demonstrate use of an edge finder  
813 Demonstrate climb and conventional milling  
824 Calculate speeds and feeds

#### **900 Power Saw**

902 Demonstrate cutting and Welding saw blades  
903 Remove and replace blades  
905 Demonstrate accurate sawing



## **1000 Maintaining machines and tools**

1007 Select prepare and store coolants, cutting oils, or compounds

1008 Inspect clean and maintain a safe working area

## **1100 Metallurgy**

1101 Identify and explain Metals classifications

1103 Identify and explain Heat Treating processes

## **1200 Use of charts and references**

1203 Utilize thread charts

1204 Demonstrate use of the Machinery's Handbook to locate specific information

## **1300 Blueprint Reading**

1304 Demonstrate dimensioning of machine parts as well as tolerance and fits

1307 Calculate material sizes based upon job needs

## **1400 CNC Programming**

1406 Demonstrate absolute and incremental positioning

1415 Identify and explain the advantages and disadvantages of CNC Machining

1416 Calculate and apply machine feeds and speeds

**Level 1 Outcomes:** Complete two NIMS projects, and be well versed in entry level manual machining.

# Course Syllabus Level 2:

## First Semester (First Marking Period)

### Projects:

Parallel Set

Hammer Handle

Slide Hammer

Parallel clamps

Center Punches

### Duty and Tasks Covered:

#### 300 Part inspection

302 Calibrate precision measuring instruments

#### 400 Benchwork

409 Assemble and disassemble parts

411 Identify and use a hand Arbor and or hydraulic press

414 Saw file grind and stone metal forming block to template

#### 500 Drill Presses

512 Utilize tapping attachments on drilled holes

#### 600 Operating Grinding Machines

607 Grind 30-degree external and internal threading tools

608 Grind single-point radius and parting tool setters

#### 700 Operating Lathes

712 Turn internal threads using a single point tool

713 Drill, counterbore, countersink, tap, and ream holes

714 Demonstrate machine tapping for internal threads

## **800 Milling Machines**

- 806 Bore precision holes to print specifications
- 807 Machine angles
- 808 Machine keyways
- 815 Demonstrate use of adjustable boring head
- 824 Calculate speeds and feeds

## **900 Power Saw**

- 906 Select proper coolants for Machining
- 907 Layout, measure, and cut straight, angular and contour shapes

## **1000 Maintaining Machines and Tools**

- 1002 Inspect/change drive pulleys and belts

## **1200 Use of Charts and References**

- 1202 Use speed and feed charts
- 1203 Utilize thread charts
- 1204 Demonstrate use of the Machinery's Handbook to locate specific information

## **1300 Blueprint Reading**

- 1306 Identify and explain auxiliary, cross-sectional, and isometric views

## **1400 CNC Programming**

- 1413 Demonstrate the dry or practice run of a CNC program before machining

## **First Semester (Second Marking Period)**

### **Projects:**

**Hammer Head**

**Depth Gage**

**Surface Gage**

**Drift Pin Set**

### **Duty and Tasks Covered:**

#### **400 Benchwork**

413 Saw file and shape sheet metal template to specifications

#### **500 Drill Presses**

513 Grind and use flat bottom drills

#### **600 Operating Grinding Machines**

607 Grind 30-degree external and internal threading tools

608 Grind single-point radius and parting tool setters

#### **700 Operating Lathes**

702 Mount and true workpiece in 3 and 4 jaw chucks

707 Turn inside and outside diameters to shoulders

708 Turn tapers

#### **800 Milling Machines**

808 Machine keyways

815 Demonstrate use of adjustable boring head

#### **1000 Maintaining Machines and Tools**

1004 Inspect and adjust machine guards

1009 Properly dispose of all waste material

#### **1100 Metallurgy**

1102 Identify and explain metal property applications

### **1300 Blueprint Reading**

1309 Identify and interpret geometric dimensioning and tolerancing

### **1400 CNC Programming**

1402 Explain and demonstrate CNC safety procedures

1404 Demonstrate use of numerical controls

## **Second Semester (Third Marking Period)**

### **Projects:**

**\*NIMS\***

**-Milling 1**

**Plumb Bob**

**Gear**

**Brass Toolmakers Hammer**

**Bearing Shaft**

### **Duty and Tasks Covered:**

#### **400 Benchwork**

412 Use utility hand grinder and precision hand grinder

413 Saw file and shape sheet metal template to specifications

#### **600 Operating Grinding Machines**

614 Grind Precision angles using a sine plate or sign bar

#### **700 Operating Lathes**

716 Demonstrate thread cutting

717 Demonstrate boring

719 Machine contour, angular, and Radial shapes with single point tool and file

#### **800 Milling Machines**

807 Machine angles

808 Machine keyways

## **1000 Maintaining Machines and Tools**

1010 Demonstrate Material Handling and storage via OSHA standards

1011 Demonstrate handling of various chemicals and lubricants via OSHA standards

## **1400 CNC Programming**

1413 Demonstrate the dry or practice run of a CNC program before machining

## **Second Semester (Fourth Marking Period)**

**Projects:**

**\*NIMS\***

**-Turning 1**

**Air Powered Engine**

**Micrometer Stand**

**Vise Stop**

**Mill Stop**

**Duty and Tasks Covered:**

**400 Benchwork**

408 Remove damaged or broken screw/tap

**600 Operating Grinding Machines**

615 Identify radial and angular wheel dressers

616 Identify cylindrical and centerless grinding operations

**1100 Metallurgy**

1103 Identify and explain heat treating processes

1104 Identify and utilize the annealing and stress relieving processes

## **1200 Use of Charts and References**

1204 Demonstrate use of the Machinery's Handbook to locate specific information

## **1400 CNC Programming**

1417 Set part 0 and tool offsets

1418 Transfer data files to and from a CNC machine

1419 Identify and demonstrate the use of MDI applications

**Level 2 Outcome:** Students should have completed 3 NIMS projects and exams by this point to keep themselves geared towards a "Advanced" certification upon graduation as well as be near ready to consider a co-opposition in the trade.

# **Course Syllabus Level 3**

## **First Semester (First Marking Period)**

### **Projects:**

**Candlestick Holders**

**Grinding Vise**

**Center Gage**

**Shim Punch Set**

**3D-Print files**

### **Duty and Tasks Covered:**

#### **300 Part inspection**

309 Identify and use the optical comparator for small part inspection

## **700 Operating Lathes**

720 Demonstrate the use of a steady rest and or follower rest

## **800 Milling Machines**

810 Demonstrate indexing head calculations and use

826 Select appropriate cutter for various milling operations

827 Demonstrate how to square a part

## **1000 Maintaining Machines and Tools**

1005 Install level and fasten down machinery

## **1100 Metallurgy**

1106 Describe material aspects for shock friction and distortion resistance

1108 Describe aspects of material brittleness, ductility, and magnetism

## **1200 Use of Charts and References**

1204 Demonstrate use of the Machinery's Handbook to locate specific information

## **1300 Blueprint Reading**

1309 Identify and interpret geometric dimensioning and tolerancing

## **1400 CNC Programming**

1405 Identify and demonstrate the use of cartesian and polar coordinate systems

1413 Demonstrate the dry or practice run of a CNC program before machining

1417 Set part 0 and tool offsets

1418 Transfer data files to and from a CNC machine

1419 Identify and demonstrate the use of MDI applications

1421 Load program setup and machine completed work in CNC turning machine



## **First Semester (Second Marking Period)**

### **Projects:**

**Grinding Vise Cont'd**

**Shift Knob**

**Sr Project begins-Invent/Innovate**

**Name Stamp-CNC in graphite**

## **Second Semester (Third Marking Period)**

### **Projects:**

**\*NIMS\***

**-CNC Milling 1**

**Grinding Vise Cont.**

**Sr Project-Invent/Innovate**

**Name Stamp-EDM in steel**

### **Duty and Tasks Covered:**

#### **300 Part inspection**

314 Describe methods used for quality control

#### **800 Milling Machines**

826 Select appropriate cutter for various milling operations

827 Demonstrate how to square a part

#### **1000 Maintaining Machines and Tools**

1006 Replace repair and adjust machine components

#### **1100 Metallurgy**

1106 Describe material aspects for shock friction and distortion resistance

1108 Describe aspects of material brittleness, ductility, and magnetism

#### **1400 CNC Programming**

1405 Identify and demonstrate the use of cartesian and polar coordinate systems

1413 Demonstrate the dry or practice run of a CNC program before machining

1417 Set part 0 and tool offsets

## **Second Semester (Fourth Marking Period)**

**Projects:**

**Sr Project-Invent/Innovate**

**\*NIMS\***

**-CNC Turning 1**

**Finish any/all existing projects**

**Duty and Tasks Covered:**

**800 Milling Machines**

825 Install and remove cutting tool holding devices properly in milling Machines

**1400 CNC Programming**

1418 Transfer data files to and from a CNC machine

1419 Identify and demonstrate the use of MDI applications

1421 Load program setup and machine completed work in CNC turning machine

**Level 3 Outcome: Students should be NIMS certified as Advanced in today's metalworking skills by having completed at least 4 NIMS certifications and ready to enter the workforce.**

## Supplemental Learning Activities

Students who participate in this program will also have opportunities to participate in the following programs and school-sponsored activities:

**SkillsUSA:** All students each can choose to participate in the “machining class” competitions at the SkillsUSA Regional Competition.

**NTHS:** Level II and Level III students who have received an “A” in their career and technical program as well as a “B” average at their sending school are eligible to become a member of the BAVTS Chapter of the National Technical Honor Society.

**Cooperative Education:** Students who have attended six quarters in their career and technical program are eligible to participate in a paid working experience during the PM session of BAVTS. Positions must be available and the students must be recommended by the CTE teacher to be eligible.

**Job Shadowing:** Students are eligible to visit business and industry partners for one or more days to view the day-to-day operations of this career area.

**Internships:** Students who have completed six or more quarters of their CTE program are eligible to work for a business and industry partner with the recommendation of the instructor and the availability of assignment.

**Field Trips:** Students in this program will on occasion attend field trips that expose them to educational experiences within the career field.