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ABSTRACT

This document is intended to help education and training institutions deliver the Machine Tool Advanced Skills Technology (MAST) curriculum to a variety of individuals and organizations. MAST consists of industry-specific skill standards and model curricula for 15 occupational specialty areas within the U.S. machine tool and metals-related industries. This volume provides the MAST standards and curriculum for the tool and die maker specialty area. (A tool and die maker is a person who produces tools, dies, and special guiding and holding devices that are used in machine tools and to produce a variety of machined parts and products.) This volume is organized in the following sections: (1) a profile of Itawamba Community College (Mississippi), the development center that produced these standards and curriculum; (2) a tool and die maker competency profile of job duties and tasks; (3) a tool and die maker duty, task, and subtask outline; (4) a course curriculum outline and course descriptions; (5) a technical workplace competencies and course crosswalk; and (6) a Secretary's Commission on Achieving Necessary Skills (SCANS) proficiencies course crosswalk. Individual syllabi for the following courses are provided: Machine Tool Technology; Introduction to Die Making Procedures; Fundamentals of Drafting; Introduction to Computers; Die Design I; Die Making I; Computer Numerical Control (CNC) Operations I; Principles of Computer Assisted Design (CAD); Die Design II; Die Making II; CNC II; Die Making III; CNC III; and Special Project. Each course syllabus includes the following: course hours, course descriptions, prerequisites, required course materials, teaching and evaluation methods, lecture and laboratory outlines, course objectives for technical and SCANS competencies, and suggested references. Two appendixes contain industry competency profiles and the pilot program narrative. (KC)

Machine Tool Advanced Skills Technology

COMMON GROUND: TOWARD A STANDARDS-BASED TRAINING SYSTEM FOR THE U.S. MACHINE TOOL AND METAL RELATED INDUSTRIES

VOLUME 9

TOOL AND DIE

of
a 15 volume set of Skills Standards
and
Curriculum Training Materials for the
PRECISION MANUFACTURING INDUSTRY

Supported by
the Office of Vocational & Adult Education
U.S. Department of Education

AUGUSTA TECHNICAL INSTITUTE

CACT CENTER FOR APPLIED COMPETITIVE TECHNOLOGIES
San Diego City College

ITAWAMBA COMMUNITY COLLEGE · 1948 ·

Moraine Valley Community College

SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

Texas State Technical College Waco

*M*achine Tool *A*dvanced *S*kills *T*echnology Program

MAST

VOLUME 9

--TOOL AND DIE --

Supported by
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U.S. Department of Education

September, 1996

GRANT INFORMATION

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Discrimination:	Title VI of the Civil Rights Act of 1964 states: "No person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance." Title IX of the Education Amendments of 1972 states: "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving federal financial assistance." Therefore, the Machine Tool Advanced Skills Technology (MAST) project, like every program or activity receiving financial assistance from the U.S. Department of Education, operated in compliance with these laws.

ACKNOWLEDGMENTS

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- U.S. Department of Education, Office of Vocational & Adult Education
- MAST Consortia of Employers and Educators

MAST DEVELOPMENT CENTERS

Augusta Technical Institute - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES

AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES

Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Central Florida Community College - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS

Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS

Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High - Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MAST PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, National Tooling and Machine Association (NTMA)

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

This report is primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 3,000 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

This material may be found on the Internet at **http://machinetool.tstc.edu**

CATALOG OF 15 VOLUMES

VOLUME 1	EXECUTIVE SUMMARY STATEMENT OF THE PROBLEM MACHINE TOOL ADVANCED SKILLS TECHNOLOGY PROJECT PROJECT GOALS AND DELIVERABLES PROJECT METHODOLOGY PROJECT CONCLUSIONS AND RECOMMENDATIONS APPENDICES
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VOLUME 3	MACHINING - CORE COURSES (MAC)
VOLUME 4	MANUFACTURING ENGINEERING TECHNOLOGY (MET)
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VOLUME 7	INDUSTRIAL MAINTENANCE (IMM)
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VOLUME 9
TOOL AND DIE MAKER

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FOREWORD

Advanced technology has changed forever the nature of employment in modern manufacturing. Traditional assembly operations are being supplanted by automation or made redundant through streamlining of the manufacturing process. In most industries, fewer low-skilled workers are needed to meet the same or higher production goals, leaving a surplus of workers to fill a smaller number of openings. At the same time, as new employment opportunities in advanced manufacturing begin to appear, finding qualified applicants to fill the positions is often difficult. Traditional candidates coming from crafts-based occupations often lack the education and knowledge of computers to operate modern manufacturing technology and processes.

The occupation of **Tool and Die Maker** epitomizes the state of transition in modern American manufacturing. Tool and Die Makers stand with one foot on the cutting edge of technology and the other in the craftsmanship of the previous era. They must be adept at computer programming and computer-aided drafting, understand computerized numerically controlled machining, stay abreast of the most recent innovations in manufacturing materials. At the same time, they must possess knowledge and expertise in conventional areas of machining, such as grinding, milling, welding, and turning, and be skilled in the use of various hand held instruments.

Recognizing the need to increase the supply of new skilled workers in this and other occupations for the metal and metals-related industries, the U.S. Department of Education launched the Cooperative Demonstration Program (Manufacturing Technologies) as part of the National Skills Standards Act of 1994. The goal of the Department initiative was to foster the development and implementation of national skill standards and a training model for certificate and Associate of Science degree programs. In July 1994, a multi-state consortium of community colleges led by Texas State Technical College received a grant awarded by the Department under the initiative. The Machine Tool Advanced Skills Technology (MAST) consortium, which includes six of the nation's leading Advanced Technology Centers (ATCs), was formed to develop, test and disseminate industry-specific skill standards and model curricula for the U.S. machine tool industry over a two year period. As part of the MAST consortium, Texas State Technical College was tasked with developing and piloting skill standards and model curricula in the technical area of Tool & Die Maker.

The diversity of knowledge and skills required by the Tool and Die Maker occupation complicates identification of entry-level Tool and Die Maker skills. While a broad background in metal-working and machining is ideal, and knowledge of metallurgy is vital, manufacturers continue to insist that the best Tool and Die Makers have the manual dexterity and hand-eye coordination of Old World craftsmen. The skill standards and curriculum presented here are the result of numerous interviews with practitioners from industry (see Appendix A) and discussions with educators, managers, supervisors, and others involved with tool and die making. Based on discussion with the other MAST consortia partners, the project presents the following definition of the new occupation:

TOOL AND DIE MAKER: *The Tool and Die Maker produces tools, dies, and special guiding and holding devices that are used in machine tools and to produce a variety of machined parts and products.*

Itawamba Community College's tool and die making curriculum is a 20-course, two year program encompassing manufacturing technology and methods and laboratory work using equipment and material standard across various industries. The present volume provides the occupational skill standards, project documentation, and course syllabi for education and training recommended as minimum preparation for an individual desiring to enter the field of Tool and Die Maker.

PARTNER OCCUPATIONAL SPECIALITY ASSIGNMENTS

Although each of the six partner college development centers possessed detailed expertise in each of the MAST 15 occupational specialities, a division of work was still very necessary to ensure completion of the project due to the enormity associated with industrial assessment and complete curriculum revision for each of the areas of investigation.

Each Collegiate Partner was responsible for development of a specialization component of the overall model. Information for the future direction of this specialization area was obtained from NIST Manufacturing Centers and/or national consortia, professional societies, and industrial support groups addressing national manufacturing needs. Each Collegiate Partner tested its specialization model utilizing local campus resources and local industry. Information gained from the local experience was utilized to make model corrections. After testing and modification, components were consolidated into a national model. These events occurred during the first year of the Program. During the second year of the Program, the national model was piloted at each of the Collegiate Partner institutions. Experience gained from the individual pilot programs was consolidated into the final national model.

What follows is a profile of the MAST development center which had primary responsibility for the compilation and preparation of the materials for this occupational specialty area. This college also had the responsibility for conducting the pilot program which was used as one of the means of validation for this program.

MAST DEVELOPMENT CENTER, TUPELO, MS
Itawamba Community College
Tupelo Campus

David Cole, President
Itawamba Community College
Charles Chrestman, Dean
Career Education and Community Services
Don Benjamin, Associate Dean
Career Education

653 Eason Boulevard
Tupelo, MS 38801
College phone: 601/842-5621, fax: 601/680-8423

Manufacturing in Mississippi

Evolving from a previously agrarian economy, the region served by Itawamba Community College now contains a significant industrial base. Approximately 45% of employed adults in the surrounding area work in manufacturing, with the predominant industries including metal-working, machinery, paper products, rubber/plastics, electrical components, furniture, apparel, and wood products. About 35-40% of all manufacturing employees work in the furniture industry. After World War II, several major metal-working companies established branch plants in the Tupelo area, a trend that has continued into the 1990's. Between 1975 and 1980, pressures of competition and technology caused a number of these companies to reconsider their continued presence in northern Mississippi, spurring action by regional economic development organizations to preserve an employment and tax base essential to the community. Many of their economic development initiatives involved the community college, leading directly to the establishment of its Tool and Die Making Technology program and introduction of training in CAD, CNC, robotics, and lasers.

Itawamba Community College

Itawamba Community College (ICC) provides university transfer programs, associate degree career programs, non-credit customized industry training, and continuing education to a rural five-county area in northeast Mississippi. Of the local population of approximately 170,000 persons, 79% are white and 19% black; the student profile at the College roughly mirrors the racial composition of the general population, and a high percentage of students are from low-income households. The mission of the College includes the mandate to provide "educational services which contribute to the needs of new, expanding, or existing businesses and industries and to the training needs of the people." Accordingly, the College's instructional programs are designed with national trends and the needs of business and industry in mind, and the objective of all courses and training is to provide both students and companies with what they need to succeed. The main campus is in Fulton and the vocational-technical campus in Tupelo.

Development Team

- **Project Director:** Don Benjamin, Associate Dean of Career Education, served as program manager and academic coordinator for the MAST project.
- **Site Coordinator**: Barry Emison was responsible for industrial assessment and skills validation, as well as development of skill standards and course/program materials for the Tool and Die Technology component of the MAST project. Barry worked closely with Steve Zimmer of Syzygy, Inc., who conducted task analysis sessions with teams of expert workers.
- **Subject Matter Experts**: Pat Masur, Basic Skills/Related Studies Instructor, served as advisor for basic academic competencies, sharing responsibility with Mr. Emison for compiling data from industry surveys and interviews during the skill standards development process. Donald Taylor and Terry Kitchens, Tool and Die Technology Instructors, served as technical advisors for workplace competencies and developed course curricula and program materials. They also served as co-instructors and coordinators for the MAST pilot program in Tool and Die Technology.

THE MAST COMPETENCY PROFILE

Development of Competency Profiles at each of the MAST sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject matter expert in the targeted technical area, generally a member of their faculty, to employ a modified version of the generally-accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current and future industry requirements. The initial skill standards developed by the subject matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview statements designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of their region's small and medium-sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross-industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

During the company interviews, MAST staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that will have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. Copies of individual company competency profiles are provided in Appendix A of this volume. These individual company Competency Profiles served two purposes. First, they showed, in a format that could be easily understood by both industry and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document for which they could claim ownership. This, in effect, made them "real" partners in the work of MAST.

Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of, as shown in the following pages.

These same duties and tasks were then included in both the Texas and National Surveys for further validation (see Volume 1). As a result of the surveys, additional refinements were made to the Competency Profiles. These changes were then incorporated into the individual course syllabi which were used for the pilot program.

The MAST Competency Profile for this occupational specialty area has been included on the following pages.

SKILLS AND KNOWLEDGE

Communication Skills
Technical Reading/Writing Skills
Ability to Comprehend Written/Verbal Instructions
Leadership Skills
Organizational Skills
Knowledge of Company Policies/Procedures
Knowledge of Employee/Employer Responsibilities
Ability to Work as Part of a Team
Knowledge of Company Quality Assurance Activities
Knowledge of Safety Regulations/Responsibilities
Project/Task Management Skills
Logical/Systematic Problem Solving Skills
Computer Skills
Numerical/Mathematical Skills
Use Measurement Tools
Use Inspection Devices
Drafting Skills
Knowledge of Industrial Materials
Knowledge of Manufacturing Processes
Mechanical Aptitude

ITAWAMBA COMMUNITY COLLEGE
MAST PROGRAM REPRESENTATIVES

Dr. Charles Chrestman
Dean/Director

Don Benjamin
Associate Dean/Site Administrator

Barry Emison
Site Coordinator

FURNISHED BY:

AIRCAP/MTD

DELTA INTERNATIONAL

SUPER SAGLESS CORPORATION

TECUMSEH PRODUCTS

THOMAS LIGHTING

FACILITATED BY:

Steven Zimmer

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Personal Ethics
Innovative

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators
magnetic tool holders, etc.)
Measuring Tools
Metal Layout Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Band Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment
CNC Machining Center and Turning Center
Jig Boring Machines
Alignment/Calibration Tools
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Composites
In-Process Gauging
Rapid Tool Changing
Expanded Communication with Shop Floor
Multi-Axis Equipment
Computer-Integrated Manufacturing
Adaptive Controls
Conversational Programming
Artificial Intelligence

COMPETENCY PROFILE

Tool & Die Maker

Prepared By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortium Partners
(V.199J40008)

Itawamba Community College
Tupelo, MS

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machines and produce a variety of products

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Maintain a clean and safe work environment	A-4 Use safe operating procedures for hand and machine tools	A-5 Use safe machining practices	A-6 Use safe lifting practices	A-7 Consult and apply MSDS for hazards of various materials						
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Perform basic algebraic operations	B-3 Perform basic trigonometric functions	B-4 Use basic geometric principles	B-5 Use and apply cartesian coordinate system								
C Demonstrate Quality Control and Management	C-1 Utilize appropriate inspection techniques	C-2 Perform appropriate use and calibration of inspection equipment	C-3 Know qualitative parameters of machinery and equipment	C-4 Maintain equipment to produce quality parts	C-5 Know and use quality systems	C-6 Write inspection procedures	C-7 Document inspection results						
D Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Demonstrate knowledge of physical properties of materials	D-3 Identify manufacturing properties of materials	D-4 Discuss classification system for metals									
E Demonstrate Knowledge of Manufacturing Processes	E-1 Know operation of vertical and horizontal mills and tooling	E-2 Know operation of engine and turret lathes and tooling	E-3 Know operation of drill presses and tooling	E-4 Know operation of surface and cylindrical grinders	E-5 Know operation of heat treating equipment	E-6 Know operation of welding equipment	E-7 Know sheet metal operations	E-8 Know operation of jig-boring machines and tooling	E-9 Know operation of tool and cutter grinders	E-10 Know operation of metal saws	E-11 Know operation of wire EDM	E-12 Estimate time required/ cost to produce a part	E-13 Know proper flow of parts through shop
	E-14 Utilize concepts and principles of fixturing	E-15 Make calculations for and use sine bar / sine plate	E-16 Make calculations for rotary table and dividing head										
F Perform CNC Programming/ CAM Tasks	F-1 Prepare and plan for CNC machining operations	F-2 Select, use, and acquire tooling systems for CNC machines	F-3 Manually program CNC machines	F-4 Use Computer-Aided-Manufacturing (CAM) system									
G Demonstrate Communication Skills	G-1 Use written correspondence	G-2 Use written technical information	G-3 Communicate technical information verbally	G-4 Use graphics for visual aid									
H Perform Drafting/CAD Tasks	H-1 Demonstrate traditional mechanical drafting skills	H-2 Use Computer-Aided Drafting (CAD) system	H-3 Use and apply GD&T methodology										
I Use Computers	I-1 Use computer operating systems	I-2 Use file management systems	I-3 Perform backup on a personal computer	I-4 Install/use software packages	J-7 Understand and apply computer terminology								

ICCTDM PM3
MAST0/111095

Duties	Tasks											
J — Interpret/Use Blueprints and Related Documents	J-1 Interpret, review, and apply blueprint notes, dimensions, and tolerances	J-2 Interpret and understand basic layout/ types of drawings	J-3 Understand and analyze bill of materials	J-4 Ascertain job requirements from drawings								
K — Perform Die Operations	K-1 Utilize basic die theory	K-2 Perform die repair	K-3 Demonstrate die making skills	K-4 Demonstrate understanding of different types of industrial dies								

THE MAST TECHNICAL WORKPLACE COMPETENCY OUTLINE

The Competency Profiles derived from the industry survey process were returned to industry and faculty members at each MAST partner college for review. Reviewers were asked to identify specific sub-tasks within each block of Duties and Tasks in the Profile; MAST staff at each college broke the sub-tasks down further into the detailed steps required to actually perform the duties and tasks of the manufacturing process. It is these detailed skill standards that were then incorporated into development of the curriculum and piloted as a training program by each of the MAST colleges. All results for the specific occupational specialty area have been organized as an outline of the duties, tasks, and sub-tasks required to demonstrate technical competency in the workplace, as shown in the following pages.

As a result of the Texas and the National Surveys, additional refinements were made to the Competency Outlines. These changes were then incorporated into the individual course syllabi.

The MAST Technical Workplace Competency Outline for this occupational specialty area has been included on the following pages.

TOOL AND DIE MAKER
TECHNICAL WORKPLACE COMPETENCIES

TOOL AND DIE MAKER...*skilled workers who produce tools, dies, and special guiding and holding devices that are used in machines and produce a variety of products.*

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives
   c. Wear safety/protective equipment as required
2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition
   b. Maintain all guards, shields, and barriers in place and in good condition
   c. Perform preventive maintenance as required
   d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean and free of debris
   b. Keep aisles/traffic areas clear of equipment and materials
   c. Store materials, tools, and instruments in organized manner
   d. Clean machine/hand tools when work is complete
4. Use Safe Operating Procedures For Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions

a. Add, subtract, multiply, and divide whole numbers
b. Add, subtract, multiply, and divide fractions
c. Add, subtract, multiply, and divide decimals
d. Interconvert fractions/decimals
e. Interconvert metric/English measurements

2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use Basic Geometric Principles
   a. Solve for surface area, perimeter, and volume of cube
   b. Solve for surface area, perimeter, and volume of rectangular solid
   c. Solve for surface area, perimeter, and volume of right triangular solid
   d. Solve for surface area, perimeter, and volume of cylinder
   e. Find diagonal of a square
5. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Calculate coordinates of bolt circle on Cartesian coordinate system
   c. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gages
   k. Use Rockwell hardness tester
   l. Know operation of coordinate measuring machine (CMM)
   m. Use surface plates
3. Know Qualitative Parameters of Machinery and Equipment

a. Differentiate between types of machinery by qualitative capabilities
b. Select appropriate processes to maintain desired tolerances
c. Discuss the effect one process might have on an earlier or later process

4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Identify Materials With Desired Properties
   a. Determine/identify service requirements (strength, hardness, etc.)
   b. Determine, interpret, and evaluate availability of materials
   c. Describe general characteristics of various metals
   d. Know concepts of/calculate statics and stresses
2. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness
   b. Define toughness
   c. Define tensile strength
   d. Define shear strength
   e. Define elasticity
   f. Define ductility
   g. Discuss the Rockwell and Brinell hardness scales
   h. Discuss the Charpy/Izod impact tests
3. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Discuss cold forming/workability of various materials
   c. Define work hardening/edge hardening
   d. Identify welding properties of various materials
   e. Demonstrate knowledge of heat treating procedures and properties
   f. Know stress relieving procedures
   g. Know/Find hardness characteristics and chemistry of various materials
4. Discuss Classification System for Metals

a. Identify and discuss types of carbon steel
b. Determine chemistry of material by classification
c. Distinguish between SAE and AISI classification systems
d. Identify designation of each digit of steel classification
e. Discuss alloy steels

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Discuss CNC machining centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC machining center
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Discuss CNC turning centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC turning center
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines
   f. Discuss drilling safety
   g. Discuss drilling operations on CNC drilling machines
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC drilling machine
4. Know Operation of Surface and Cylindrical Grinders
   a. Define grinders, surface and cylindrical
   b. Explain types and maintenance of grinding wheels
   c. Set-up and operate grinding machines
   d. Explain machine components and accessories of grinding machines

e. Explain grinding processes
f. Discuss grinding safety

5. Know Operation of Heat Treating Equipment and Processes
   a. Describe types of heat treating equipment
   b. Set-up and operate heat treating equipment
   c. Explain machine components and accessories of heat treating equipment
   d. Explain heat treating procedures
   e. Discuss heat treating safety
6. Know Operation of Welding Equipment and Processes
   a. Identify various types of welding equipment
   b. Identify and discuss the difference in welding processes
   c. Inspect welds for cracks and penetration
   d. Discuss welding safety
7. Know Sheet Metal Operations
   a. Discuss gas/plasma cutting equipment and processes
   b. Discuss operation of punch/brake presses and tooling
   c. Discuss operation of plate shears
   d. Calculate tonnages required for press/shear operations
   e. Calculate blank dimensions of developed parts
   f. Use yield tables for bending sheet metal
   g. Discuss fabrication of sheet metal parts
   h. Demonstrate layout-on-metal
   i. Apply conservation-of-material concepts
8. Know Operation of Jig-Boring Machines and Tooling
   a. Define jig-boring machine
   b. List, describe, and give function and maintenance of different types of tooling used on jig-boring machines
   c. Set-up and operate jig-boring machine
   d. Explain machine components and accessories of jig-boring machines
   e. Explain jig-boring process
   f. Discuss safety on jig-boring machine
   g. Calculate speeds and feeds based on materials and tooling
9. Know Operation of Tool and Cutter Grinders
   a. Define tool/cutter grinder
   b. Discuss dressing and maintenance of grinding wheels
   c. Explain machine components and accessories of tool/cutter grinder
   d. Discuss tool and cutter grinder safety
10. Know Operation of Metal Saws
   a. Define band saw, horizontal and vertical
   b. Set-up and operate band saw
   c. Define abrasive cut-off saw
   d. Set-up and operate abrasive cut-off saw
   e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades
   f. Weld and maintain band saw blade

g. Discuss band saw safety
h. Calculate speeds and feeds based on materials and tooling
i. Explain machine components and accessories of band saws
j. Calculate proper length of band saw blade

11. Know Operation of Wire EDM
    a. Define EDM
    b. Explain EDM process
    c. Set-up and operate CNC wire EDM
    d. Discuss EDM safety
    e. Calculate E-pac value for wire EDM
    f. Explain machine components and accessories of wire EDM
12. Estimate Time Required/Cost to Produce a Part
    a. Determine processes required to produce part
    b. Calculate actual machining and handling time
    c. Calculate material quantity and cost
    d. Calculate labor and overhead cost
13. Know Proper Flow of Parts Through Shop
    a. Discuss proper order of processes
    b. Discuss ergonomic aspects of plant layout
14. Utilize Concepts and Principles of Fixturing
    a. Determine need for fixture/jig
    b. Design appropriate fixture/jig
    c. Identify components used in fixtures/jigs
    d. Disassemble and assemble fixture/jig
    e. Discuss relationship between accuracy of fixture and accuracy/repeatability of parts
15. Make Calculations For and Use Sine Bar/Sine Plate
    a. Define sine bar/sine plate
    b. Calculate gage block buildup for sine bar/sine plate
    c. Set-up and use sine bar/sine plate
16. Make Calculations For and Use Rotary Table and Dividing Head
    a. Set-up and use rotary table/dividing head for machining operations
    b. Make calculations for number of rotations required
    c. Determine/select appropriate index plate for dividing head

F. PERFORM CNC PROGRAMMING/CAM TASKS

1. Prepare and plan for CNC machining operations
    a. Plan sequence of machining events
    b. Determine proper tooling/fixtures required for machining
    c. Calculate speeds, feeds, and depth-of-cut for machining
    d. Explain the x, y, and z, axis on CNC machines
2. Select and Use Tooling Systems for CNC Machines
    a. Understand machinability and chip formation
    b. Select proper insert materials and geometry
    c. Select proper tooling system

d. Define and discuss application of HSS, carbide, and borazon cutting tools

3. Manually Program CNC Machines
   a. Plan and write programs for CNC machines
   b. Use MDI panel on machine to program/edit programs
   c. Set and use tooling offsets at CNC machine
   d. Discuss/use canned or bar cycles in program
4. Use Computer-Aided Manufacturing (CAM) System
   a. Create toolpath geometry using CAM system
   b. Interconvert CAD and CAM files using acceptable exchange format
   c. Transfer files from CAM system to machine
   d. Configure CAM system parameters

G. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
   a. Read, write, interpret, and apply memorandums
   b. Read, write, interpret, and apply business letters
   c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
   a. Read, write, interpret, and apply technical reports
   b. Read, write, interpret, and apply written procedures
   c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
   a. Demonstrate ability to listen to and understand verbal technical information/instructions
   b. Ask appropriate questions to ascertain needed information
   c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
   a. Create, read, and apply graphs
   b. Create, read, and apply charts
   c. Create, read, and apply graphical illustrations

H. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
   a. Demonstrate use of drafting machine and instruments
   b. Demonstrate drafting technique to create basic geometric elements
   c. Demonstrate isometric sketching of objects
   d. List and apply the three primary planes of projection
   e. List and apply the six principle views
   f. Use and apply auxiliary views
   g. Create sectional views
2. Use Computer-Aided Drafting (CAD) System
   a. Create geometry using CAD system
   b. Create 3-D solid models
   c. Interconvert CAD and accepted drawing exchange formats
   d. Configure CAD system parameters

e. Use peripheral devices

3. Use and Apply Geometric Dimensioning and Tolerancing (GD&T) Methodology
   a. Distinguish between conventional and geometric dimensioning and tolerancing
   b. Explain and use geometric positional tolerancing
   c. Explain and use tolerances of form
   d. Explain and use the feature control symbol
   e. Explain and use modifiers in geometric dimensioning and tolerancing

I. USE COMPUTERS

1. Use Computer Operating Systems
   a. Explain the phrase "IBM compatible"
   b. Use DOS operating system/DOS commands
   c. Use Windows
   d. Use computer network system
2. Use File Management Systems
   a. Discuss file management concepts
   b. Create/remove directories
   c. Copy files from floppy disks to hard drive
3. Perform Backup on a Personal Computer
   a. Discuss need to backup hard disk
   b. Perform complete backup of hard disk
   c. Perform backup of selected files and directories
   d. Restore backup set to hard disk
   e. Discuss need for/make system disk
4. Install/Use Software Packages
   a. Install software package to hard disk
   b. Configure system parameters for software package
   c. Use word processor software (WordPerfect, MS Word)
   d. Use spreadsheet software (Lotus, MS Excel)
5. Understand and Apply Computer Terminology
   a. Define Read Only Memory (ROM)
   b. Define Random Access Memory (RAM)
   c. Define cache memory
   d. Define byte, kilobyte, megabyte
   e. Define Central Processing Unit (CPU)
   f. Discuss processor speed
   g. Understand RS-232 protocol

J. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing

e. Identify tolerances on a drawing
f. Discuss GD&T methodology

2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements From Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

K. PERFORM DIE OPERATIONS

1. Utilize Basic Die Theory and Principles of Die Design
   a. Discuss shearing action on metal (3 stages)
   b. Define/calculate cutting clearance
   c. Define/calculate proper shut-height of die set
   d. Define/calculate offset displacement
   e. Define/calculate stripping pressure
   f. Define/calculate cutting length of piece part
   g. Define/calculate die progression
   h. Design stock strip layout
   i. Determine die feed direction
   j. Explain notch, pierce, pilot, form, and cut-off stations
   k. Determine stop block length
   l. Determine press tonnage requirements
   m. Define/calculate slug clearance
   n. Explain operation of die set to make piece part
   o. Explain spring back in form dies
   p. Explain bending action in V-form dies
   q. Explain coining in dies
   r. Identify components of die set
   s. Discuss materials of die components
2. Perform Die Repair
   a. Disassemble and assemble die set
   b. Visually inspect die components for damage
   c. Identify component parts to be repaired/sharpened
   d. Determine method of repairing/sharpening
   e. Determine material for replacement parts
   f. Manufacture replacement parts
   g. Demonstrate setting correct punch entry

3. Demonstrate Die Making Skills
   a. Identify component parts from die blueprint
   b. Determine material/purchased parts requirements
   c. Utilize die making procedures to make component parts
   d. Utilize die making procedures to mount component parts
   e. Demonstrate mounting of die set in press machine
   f. Cycle die set in press machine and inspect operation
   g. Inspect piece part for accuracy
4. Demonstrate Understanding of Different Types of Industrial Dies
   a. Describe the operation and major components of blanking or piercing dies
   b. Describe the operation and major components of bending or forming dies
   c. Describe the operation and major components of draw dies
   d. Describe the operation and major components of compression dies
   e. Describe the operation and major components of progressive dies
   f. Describe the operation and major components of compound dies
   g. Describe the operation and major components of combination dies

THE MAST PILOT PROGRAM CURRICULUM AND COURSE DESCRIPTIONS

After completing the Competency Profile and Technical Workplace Competency Outline for each occupational specialty area, each MAST partner reviewed their existing curricula against the industry-verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the MAST grant proposal:

- Pilot Program: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."

- Student Assessment: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry level and already-employed technicians."

(Note: All occupational specialty areas were not pilot tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

Included on the following pages is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. This curriculum listing included course names and numbers from the college which conducted the pilot program. The curriculum also shows the number of hours assigned to each of the courses (lecture, lab and credit hours). Also included is a description of each of the courses.

TOOL & DIE MAKING TECHNOLOGY
CURRICULUM
1995 - 1996

FIRST SEMESTER		LEC	LAB	CR
MSV 1016	Machine Tool Technology	3	6	6
TDT 1114	Introduction to Die Making Procedures	2	4	4
DDT 1113	Fundamentals of Drafting	2	2	3
CPT 1113	Introduction to Computers	2	2	3
MAT 1233	Intermediate Algebra	3	0	3
		12	14	19

SECOND SEMESTER				
TDT 1133	Die Design I	2	2	3
TDT 1146	Die Making I	3	6	6
MST 2713	Computer Numerical Control Operations I	2	2	3
DDT 1313	Principles of CAD	2	2	3
ENG 1113	English Composition I	3	0	3
		12	12	18

THIRD SEMESTER				
TDT 2153	Die Design II	2	2	3
TDT 2166	Die Making II	3	6	6
MST 2723	Computer Numerical Control Operations II	2	2	3
MAT 1323	Trigonometry	3	0	3
SPT 1113	Oral Communications	3	0	3
		13	10	18

FOURTH SEMESTER				
TDT 2174	Die Making III	2	4	4
MST 2733	Computer Numerical Control Operations III	2	3	3
TDT 2183	Special Project	1	4	3
	Humanities/Fine Arts Elective	3	0	3
	Social or Behavioral Science Elective	3	0	3
		11	11	16
	Program Totals	48	47	71

TOOL AND DIE MAKING TECHNOLOGY
COURSE DESCRIPTIONS
1995-1996

MSV 1016 **Machine Tool Technology** (3-6-6) This course is composed of fundamental skills related to machine tool operations. Topics covered in the course include safety, precision measurement, blueprint reading, hand and bench work, metallurgy, and the operation of a variety of machine tools.

TDT 1114 **Introduction to Die Making Procedures** (2-4-4) This course is an introduction to tool and die making procedures including an orientation to metallurgy and die repair. Students are instructed and given practice in the inspection, disassembly, fabrication, and reassembly of die components.

TDT 1133 **Die Design I** (2-2-3) This course is an introduction to the design of industrial dies and the machining characteristics of die components. This course serves as a continuation of TDT 1114 and MSV 1016. The student is introduced to additional machining skills that will be encountered in typical die shops in the building of dies, jigs, fixtures, and precision machine parts.

TDT 2153 **Die Design II** (2-2-3) This course is a continuation of TDT 1133 with emphasis on actual die design and construction. Instruction is given on the considerations involved in developing die components, such as calculation of clearances, cutting force, and press tonnage requirements.

MST 2713 **CNC Operations I** (2-2-3) This course is an introduction to computer numerical control machines. Included is instruction and practice related to the use of the Cartesian coordinate system, programming codes and styles, and operation of basic CNC machines.

MST 2723 **CNC Operations II** (2-2-3) This course is a continuation of MST 2713 with additional instruction in writing and editing CNC code manually, utilizing more advanced commands and cycles. Additionally, students will be introduced to the use of a Computer-Aided-Manufacturing (CAM) system for the creation of code.

MST 2733 **CNC Operations III** (2-3-3) This course is a continuation of MST 2713 and MST 2723 with additional instruction and practice in the use of the Computer-Aided-Manufacturing (CAM) system for creation of code. Also, the student will be introduced to the Wire Electrical Discharge Machine (EDM) and the Coordinate Measuring Machine (CMM).

TDT 1146 **Die Making I** (3-6-6) This course is a continuation of TDT 1114 with instruction and practice in building a complete functional die from a blueprint. Emphasis is placed on analyzing requirements, managing the project toward completion, and becoming proficient in shop practices and procedures.

TDT 2166 **Die Making II** (3-6-6) This course is a continuation of TDT 1146 with instruction and practice in building a progressive die from a blueprint. Emphasis is placed on the application of the die building procedures learned in TDT 1114 and TDT 1146 toward fabricating more complex dies.

TDT 2174 **Die Making III** (2-4-4) This course serves as a continuation of TDT 2166 with instruction and practice in building a compound die from a blueprint. Emphasis is placed on the application of the die building procedures learned in the TDT 1146 and TDT 2166 toward fabricating more complex dies. Instruction and practice is also given on the use of the Wire Electrical Discharge Machine in the construction of die components.

TDT 2183 **Special Project** (1-4-3) This course is designed to provide the student with practical application of skills and knowledge gained through other courses in the Tool and Die program. Students will apply material learned in previous and concurrent classes to design, produce, and test an industrial quality die. Emphasis is placed on the student making decisions, setting priorities and time lines, and realizing the overall responsibility of producing a quality product in an allotted time.

TOOL & DIE MAKING TECHNOLOGY
SUPPORT COURSES
1995-1996

DDT 1113 — **Fundamentals of Drafting** A course designed to give basic information related to instruments, equipment, principles and techniques used in drafting. Emphasis is placed on drafting conventional practices.

CPT 1113 — **Introduction to Computers** Introduction to information processing concepts and applications including operating systems, word processing, electronic spreadsheets, data management, graphics, and BASIC programming.

MAT 1233 — **Intermediate Algebra** This course is designed for students whose qualifications are deficient for college algebra or technical math and for students whose curriculum requires three hours of mathematics for graduation. This serves as a pre-requisite for statistics. Materials covered include algebraic factoring, fractions, problem solving, roots and radicals, quadratics, graphs, simultaneous equation and basic geometrical concepts. Prerequisite: One year high school algebra or MAT 1213, College Mathematics I.

DDT 1313 — **Principles of CAD** This course will use CAD machines to design and draw various problems in the architectural, mechanical, and civil drafting areas. Emphasis will be placed on the operations of the CAD system to solve these problems.

ENG 1113 — **English Composition I** A study of grammar and composition, with emphasis on the sentence and the paragraph. Reading, frequent themes.

MAT 1323 — **Trigonometry** This course is a study of solutions of right and oblique triangles, identities, trigonometric equations, and polar and parametric equations.

SPT 1113 — **Oral Communication** (Principles of Speech) Correct and effective English; correct pronunciation; breath control; study and practice in making speeches for all occasions, major emphasis on organization of material; and practice in speaking before the group.

THE MAST TECHNICAL WORKPLACE COMPETENCY/COURSE CROSSWALK

Upon development of appropriate curricula for the pilot programs, each MAST college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competency/Course Crosswalk in the following pages presents the match between industry-identified duties and tasks and the pilot curriculum for . Course titles are shown in columns, duties and tasks in rows. The Exit Level Proficiency Scale, an ascending scale with 5 the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1-5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

Included on the following pages is the Technical Workplace Competency/Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry level employees have been incorporated into the development of the course syllabi.

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY: TOOL AND DIE

	Machine Tool Technology	Intro Die Making Procedures	Die Design I	Die Design II	CNC Operations I	CNC Operations II	CNC Operations III	Die Making I	Die Making II	Die Making III	Special Project	Fundamentals of Drafting	Principles of CAD	Introduction to Computers	Oral Communication	Intermediate Algebra	Trigonometry	English Composition I	Humanities Elective	Social Science Elective	EXIT PROFICIENCY LEVEL
A. PRACTICE SAFETY																					
A-1 Follow Safety and All Safety Regulations/Requirements	X	X	X	X	X	X	X	X	X	X	X										4
A-2 Maintain Safe Equipment and Machinery	X	X	X	X	X	X	X	X	X	X	X										4
A-3 Maintain a Clean and Safe Work Environment	X	X	X	X	X	X	X	X	X	X	X										4
A-4 Use Safe Operating Procedures for Hand and Machine Tools	X	X	X	X	X	X	X	X	X	X	X										4
A-5 Use Safe Machining Practices	X	X	X	X	X	X	X	X	X	X	X										4
A-6 Use Safe Lifting Practices	X	X	X	X	X	X	X	X	X	X	X										4
A-7 Consult and Apply MSDS for Hazards of Various Materials	X	X	X	X	X	X	X	X	X	X	X										2
B. APPLY MATHEMATICAL CONCEPTS																					
B-1 Perform Basic Arithmetic Functions	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X				4
B-2 Perform Basic Algebraic Operations	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X				4
B-3 Perform Basic Trigonometric Functions	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X				4
B-4 Use Basic Geometric Principles												X	X			X	X				2
B-5 Use and Apply Cartesian Coordinate System	X	X	X	X	X	X	X	X	X	X	X					X	X				4
C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT																					
C-1 Utilize Appropriate Inspection Techniques	X	X	X	X	X	X	X	X	X	X	X										4
C-2 Perform Appropriate Use and Calibration of Inspection Equipment	X	X	X	X	X	X	X	X	X	X	X										4
C-3 Know Qualitative Parameters of Machinery and Equipment	X	X	X	X	X	X	X	X	X	X	X										4
C-4 Maintain Equipment to Produce Quality Parts	X	X	X	X	X	X	X	X	X	X	X										4
C-5 Know and Use Quality Systems	X	X	X	X	X	X	X	X	X	X	X										2
C-6 Write Inspection Procedures	X	X	X	X	X	X	X	X	X	X	X										4
C-7 Document Inspection Results	X	X	X	X	X	X	X	X	X	X	X										3
D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS																					
D-1 Identify Materials With Desired Properties	X	X	X	X				X	X	X	X										2
D-2 Demonstrate Knowledge of Physical Properties of Materials	X	X	X	X	X	X	X	X	X	X	X										3
D-3 Identify Manufacturing Properties of Materials	X	X	X	X	X	X	X	X	X	X	X										3
D-4 Discuss Classification System for Metals	X	X	X	X				X	X	X	X										3
E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES																					
E-1 Know Operation of Vertical and Horizontal Mills and Tooling	X	X	X	X	X	X	X	X	X	X	X										4
E-2 Know Operation of Engine and Turret Lathes and Tooling	X	X	X	X	X	X	X	X	X	X	X										4

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY: TOOL AND DIE

	Machine Tool Technology	Intro Die Making Procedures	Die Design I	Die Design II	CNC Operations I	CNC Operations II	CNC Operations III	Die Making I	Die Making II	Die Making III	Special Project	Fundamentals of Drafting	Principles of CAD	Introduction to Computers	Oral Communication	Intermediate Algebra	Trigonometry	English Composition I	Humanities Elective	Social Science Elective	EXIT PROFICIENCY LEVEL
E-3 Know Operation of Drill Presses and Tooling	X	X	X	X	X	X	X	X	X	X	X										4
E-4 Know Operation of Surface and Cylindrical Grinders	X	X	X	X				X	X	X	X										4
E-5 Know Operation of Heat Treating Equipment and Processes	X	X	X	X				X	X	X	X										4
E-6 Know Operation of Welding Equipment and Processes	X	X	X	X				X	X	X	X										2
E-7 Know Sheet Metal Operations	X	X	X	X				X	X	X	X										2
E-8 Know Operation of Jig-Boring Machines and Tooling	X	X	X	X				X	X	X	X										4
E-9 Know Operation of Tool and Cutter Grinders	X	X	X	X				X	X	X	X										3
E-10 Know Operation of Metal Saws	X	X	X	X				X	X	X	X										4
E-11 Know Operation of Wire EDM							X		X	X	X										4
E-12 Estimate Time Required/Cost to Produce a Part	X	X	X	X	X	X	X	X	X	X	X										3
E-13 Know Proper Flow of Parts Through Shop	X	X	X	X	X	X	X	X	X	X	X										4
E-14 Utilize Concepts and Principles of Fixturing	X	X	X	X	X	X	X	X	X	X	X										3
E-15 Make Calculations For and Use Sine Bar/Sine Plate	X	X	X	X				X	X	X	X										4
E-16 Make Calculations For and Use Rotary Table and Dividing Head			X	X				X	X	X	X										4
F. PERFORM CNC PROGRAMMING/CAM TASKS																					
F-1 Prepare and Plan for CNC Machining Operations					X	X	X				X										4
F-2 Select and Use Tooling Systems for CNC Machines					X	X	X				X										3
F-3 Manually Program CNC Machines					X	X	X				X										4
F-4 Use Computer-Aided Manufacturing (CAM) System						X	X				X										4
G. DEMONSTRATE COMMUNICATION SKILLS																					
G-1 Use Written Correspondence	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			4
G-2 Use Written Technical Information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			3
G-3 Communicate Technical Information Verbally	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				4
G-4 Use Graphics for Visual Aid	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				4
H. PERFORM DRAFTING/CAD TASKS																					
H-1 Demonstrate Traditional Mechanical Drafting Skills	X	X	X	X	X	X	X	X	X	X	X	X	X								4
H-2 Use Computer-Aided Drafting (CAD) System				X			X				X		X								3
H-3 Understand and Apply Geometric Dimensioning and Tolerancing (GD&T) Methodology				X							X	X	X								4
I. USE COMPUTERS																					
I-1 Use Computer Operating Systems					X	X	X				X			X							4

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY: TOOL AND DIE

	Machine Tool Technology	Intro Die Making Procedures	Die Design I	Die Design II	CNC Operations I	CNC Operations II	CNC Operations III	Die Making I	Die Making II	Die Making III	Special Project	Fundamentals of Drafting	Principles of CAD	Introduction to Computers	Oral Communication	Intermediate Algebra	Trigonometry	English Composition I	Humanities Elective	Social Science Elective	EXIT PROFICIENCY LEVEL
I-2 Use File Management Systems					X	X	X				X		X	X							4
I-3 Perform Backup on a Personal Computer														X							4
I-4 Install/Use Software Packages							X							X	X			X	X	X	3
I-5 Understand and Apply Computer Terminology							X							X							4
J. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS																					
J-1 Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances	X	X	X	X	X	X	X	X	X	X	X	X	X								4
J-2 Interpret and Understand Basic Layout/Types of Drawings	X	X	X	X	X	X	X	X	X	X	X	X	X								4
J-3 Understand and Analyze Bill-Of-Materials	X	X	X	X	X	X	X	X	X	X	X	X	X								4
J-4 Ascertain Job Requirements from Drawings	X	X	X	X	X	X	X	X	X	X	X	X	X								4
K. PERFORM DIE OPERATIONS																					
K-1 Utilize Basic Die Theory		X		X				X	X	X	X										4
K-2 Perform Die Repair		X		X				X	X	X	X										4
K-3 Demonstrate Die Making Skills		X	X	X				X	X	X	X										4
K-4 Demonstrate Understanding of Different Types of Industrial Dies				X						X	X										4

TOOL AND DIE MAKER
TECHNICAL WORKPLACE COMPETENCIES
EXIT LEVEL PROFICIENCY MATRIX

Tool and Die Maker: skilled workers who produce tools, dies, and special guiding and holding devices that are used in machines and produce a variety of products.

The following matrix identifies the five exit levels of technical workplace competencies for the Associate of Applied Science degree at Itawamba Community College, Tupelo, Mississippi.

EXIT LEVEL OF PROFICIENCY					
Technical Workplace Competency	**1**	**2**	**3**	**4**	**5**
	rarely	routinely with supervision	routinely with limited supervision	routinely without supervision	initiates/ improves/ modifies and supervises others

THE MAST SCANS/COURSE CROSSWALK

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT' the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources:	Identifies, organizes, plans, and allocates resources
Interpersonal:	Works with others
Information:	Acquires and uses information
Systems:	Understands complex inter-relationships
Technology:	Works with a variety of technologies

FOUNDATION SKILLS:

Basic Skills:	Reads, writes, performs arithmetic and mathematical operations, listens and speaks
Thinking Skills:	Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
Personal Qualities:	Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

Recognizing the value of SCANS proficiencies to job performance, as well as the growing mandate in many states to include SCANS activities in course curricula, MAST asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area. MAST also incorporated evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed MAST staff to modify course content where needed to strengthen achievement of SCANS competencies.

The following pages present the SCANS/Course Crosswalk for the pilot curriculum in Courses are listed along the top and SCANS competencies and foundations are shown along the left side of the matrix. An exit level proficiency matrix for SCANS competencies and foundation skills is provided as well.

As "soft" skills, the SCANS competencies are inherently difficult to quantify. MAST realizes that some faculty will emphasize the SCANS more or less than others. The SCANS/Course Crosswalk matrix has been included with this course documentation to show the importance of these "soft skills" and the importance of their being addressed in the classroom (particularly in technical classes). In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.

Included on the following pages is the SCANS/Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the "soft skills" (SCANS) which were identified by industry as being necessary for entry level employees have been incorporated into the development of the course syllabi. Also included is a matrix which defines the exit level of proficiency scale (1-5).

SCANS/Course

CROSSWALK

TOOL AND DIE

COMPETENCY	Machine Tool Technology	Intro Die Making Procedures	Die Design I	Die Design II	CNC Operations I	CNC Operations II	CNC Operations III	Die Making I	Die Making II	Die Making III	Special Project	Fundamentals of Drafting	Principles of CAD	Introduction to Computers	Oral Communication	Intermediate Algebra	Trigonometry	English Composition I	Humanities Elective	Social Science Elective	EXIT PROFICIENCY LEVEL
(RS) RESOURCES:																					
A. Allocates time	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
B. Allocates money	X	X	X	X	X	X	X	X	X	X	X										2
C. Allocates material and facility resources	X	X	X	X	X	X	X	X	X	X	X	X	X	X							4
D. Allocates human resources	X	X	X	X	X	X	X	X	X	X	X	X	X						X	X	1
(IN) INTERPERSONAL SKILLS:																					
A. Participates as a member of a team	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Teaches others	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X						1
C. Serves clients/customers	X	X	X	X	X	X	X	X	X	X	X	X	X	X							2
D. Exercises leadership	X	X	X	X	X	X	X	X	X	X	X	X	X		X						1
E. Negotiates	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	2
F. Works with cultural diversity	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
(IF) INFORMATION SKILLS:																					
A. Acquires and evaluates information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Organizes and maintains information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. Interprets and communicates information	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
D. Uses computers to process information				X	X	X	X				X		X								2
(SY) SYSTEMS:																					
A. Understands systems	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	4
B. Monitors and corrects performance	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X					2
C. Improves and designs systems	X	X	X	X	X	X	X	X	X	X	X	X	X	X							1
(TE) TECHNOLOGY:																					
A. Selects technology	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Applies technology to task	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. Maintains and troubleshoots technology	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3

SCANS/Course

CROSSWALK

TOOL AND DIE

FOUNDATION SKILLS	Machine Tool Technology	Intro Die Making Procedures	Die Design I	Die Design II	CNC Operations I	CNC Operations II	CNC Operations III	Die Making I	Die Making II	Die Making III	Special Project	Fundamentals of Drafting	Principles of CAD	Introduction to Computers	Oral Communication	Intermediate Algebra	Trigonometry	English Composition I	Humanities Elective	Social Science Elective	EXIT PROFICIENCY LEVEL
(BS) BASIC SKILLS:																					
A. Reading	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Writing	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. Arithmetic and mathematics	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X				4
D. Listening	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
E. Speaking	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
(TS) THINKING SKILLS:																					
A. Creative thinking	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
B. Decision making	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
C. Problem solving	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	3
D. Seeing things in the mind's eye	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
E. Knowing how to learn	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
F. Reasoning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
(PQ) PERSONAL QUALITIES:																					
A. Responsibility	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
B. Self-esteem	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
C. Social	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
D. Self-management	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4
E. Integrity/honesty	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	4

SCANS
COMPETENCIES AND FOUNDATION SKILLS
EXIT LEVEL PROFICIENCY MATRIX

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT' the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

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FOUNDATION SKILLS:

Basic Skills:	Reads, writes, performs arithmetic and mathematical operations, listens and speaks
Thinking Skills:	Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons
Personal Qualities:	Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

The following matrix identifies the five exit levels of proficiency that are needed for solid job performance.

EXIT LEVEL OF PROFICIENCY					
SCANS Competencies and Foundation Skills	**1**	**2**	**3**	**4**	**5**
	rarely	routinely with supervision	routinely with limited supervision	routinely without supervision	initiates/ improves/ modifies and supervises others

MAST/03/021996

THE MAST COURSE SYLLABI
"PILOT PROGRAM"

MAST has produced a very unique set of course outlines, driven and validated by industry and encompassing the broad range of technologies covered by the MAST grant. The course outlines also include proposed SCANS activities that will be useful to an instructor in preparing students to enter the workforce of the future.

Included in the following pages are final course outlines developed and refined in the process of piloting the MAST training programs. The outlines include a brief course description; required course materials (e.g., textbook, lab manual, and tools, if available); proposed method of instruction; proposed lecture and lab outlines; and detailed course objectives for both Technical Workplace Competencies and SCANS Competencies.

These outlines were completed and revised during the second year of MAST, following completion of the pilot phase. The outlines are intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

Included on the following pages are the Course Syllabi for each of the courses which were taught during the pilot program.

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

MACHINE TOOL TECHNOLOGY

MAST PROGRAM
COURSE SYLLABUS
MACHINE TOOL TECHNOLOGY

Lecture hours/week: 3 **Lab hours/week: 6** **Credit hours: 6**

COURSE DESCRIPTION:

This course is composed of fundamental skills related to machine tool operations. Topics covered in the course include safety, precision measurement, blueprint reading, hand and bench work, metallurgy, and the operation of a variety of machine tools.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook:	Technology of Machine Tools, Krar, Oswald, St. Amand, McGraw-Hill., 4th Ed.
	Student's Shop Reference Handbook, Edward Hoffman, Industrial Press
Lab Manual:	Workbook for Machine Tools, Krar, Oswald, St. Amand, McGraw-Hill., 4th Ed.

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Machine Tools	1-7	
Shop Safety	17-22	
Blueprint Reading	----	
Precision Measurement & Inspection	34-99	
Physics of Metal Cutting	142-153	
Cutting Tool Materials	532-555	
The Engine Lathe	216-306	
Layout	100-116	
The Bandsaw	154-174	
Hand Tools and Bench Work	117-141	
The Milling Machine	323-416	
Cutting Fluids	556-565	
Drilling Machines	175-215	
The Grinding Machine	479-531	
Metallurgy	566-602	
Other Manufacturing Processes	Handout	—
	Total Lecture Hours	**48**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Shop Orientation and Safety	2
Inspection and Measurement	2
Grinding a Lathe Tool	2
Use of the Engine Lathe	3
Project (Turned Shaft)	9
Thread Cutting on the Lathe	3
Layout	2
Use of the Bandsaw	2
Hand Tools and Bench Work	2
Use of the Milling Machine	3
Project (T-Bolts)	6
Use of the Drilling Machine	2
Project (Parallel Clamp)	9
Use of the Grinding Machine	2
Heat Treatment of Steel	2
Project (V-Block)	15
Project (Mini-Vise)	30
Total Lab Hours	**96**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/Requirements

a. Comply with established company and OSHA regulations
b. Interpret safety manual directives
c. Wear safety/protective equipment as required

2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition
   b. Maintain all guards, shields, and barriers in place and in good condition
   c. Perform preventive maintenance as required
   d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean and free of debris
   b. Keep aisles/traffic areas clear of equipment and materials
   c. Store materials, tools, and instruments in organized manner
   d. Clean machine/hand tools when work is complete
4. Use Safe Operating Procedures for Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas

3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gauges
   k. Use Rockwell hardness tester
   l. Use surface plates
3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Identify Materials With Desired Properties

a. Describe general characteristics of various metals

2. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness
   b. Define toughness
   c. Define tensile strength
   d. Define shear strength
   e. Define elasticity
   f. Define ductility
   g. Discuss the Rockwell and Brinell hardness scales
   h. Discuss the Charpy/Izod impact tests
3. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Discuss cold forming/workability of various materials
   c. Define work hardening/edge hardening
   d. Identify welding properties of various materials
   e. Demonstrate knowledge of heat treating procedures and properties
   f. Know stress relieving procedures
   g. Know/find hardness characteristics and chemistry of various materials
4. Discuss Classification System for Metals
   a. Identify and discuss types of carbon steel
   b. Determine chemistry of material by classification
   c. Distinguish between SAE and AISI classification systems
   d. Identify designation of each digit of steel classification
   e. Discuss alloy steels

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Calculate speeds and feeds based on materials and tooling
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Calculate speeds and feeds based on materials and tooling
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines

d. Explain machine components and accessories of drilling machines
e. Explain processes performed on drilling machines
f. Discuss drilling safety
g. Calculate speeds and feeds based on materials and tooling

4. Know Operation of Surface and Cylindrical Grinders
   a. Define grinders, surface and cylindrical
   b. Explain types and maintenance of grinding wheels
   c. Set-up and operate grinding machines
   d. Explain machine components and accessories of grinding machines
   e. Explain grinding processes
   f. Discuss grinding safety
5. Know Operation of Heat Treating Equipment and Processes
   a. Describe types of heat treating equipment
   b. Set-up and operate heat treating equipment
   c. Explain machine components and accessories of heat treating equipment
   d. Explain heat treating procedures
   e. Discuss heat treating safety
6. Know Operation of Welding Equipment and Processes
   a. Identify various types of welding equipment
   b. Identify and discuss the difference in welding processes
   c. Inspect welds for cracks and penetration
   d. Discuss welding safety
7. Know Sheet Metal Operations
   a. Discuss fabrication of sheet metal parts
   b. Demonstrate layout-on-metal
   c. Apply conservation-of-material concepts
8. Know Operation of Jig-Boring Machines and Tooling
   a. Define jig-boring machine
   b. List, describe, and give function and maintenance of different types of tooling used on jig-boring machines
   c. Set-up and operate jig-boring machine
   d. Explain machine components and accessories of jig-boring machines
   e. Explain jig-boring process
   f. Discuss safety on jig-boring machine
   g. Calculate speeds and feeds based on materials and tooling
9. Know Operation of Tool and Cutter Grinders
   a. Define tool/cutter grinder
   b. Discuss dressing and maintenance of grinding wheels
   c. Explain machine components and accessories of tool/cutter grinder
   d. Discuss tool and cutter grinder safety
10. Know Operation of Metal Saws
   a. Define band saw, horizontal and vertical
   b. Set-up and operate band saw
   c. Define abrasive cut-off saw
   d. Set-up and operate abrasive cut-off saw
   e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades
   f. Weld and maintain band saw blade

g. Discuss band saw safety
h. Calculate speeds and feeds based on materials and tooling
i. Explain machine components and accessories of band saws
j. Calculate proper length of band saw blade

11. Estimate Time Required/Cost to Produce a Part
    a. Determine processes required to produce part
    b. Calculate actual machining and handling time
    c. Calculate material quantity and cost
    d. Calculate labor and overhead cost
12. Know Proper Flow of Parts Through Shop
    a. Discuss proper order of processes
    b. Discuss ergonomic aspects of plant layout
13. Utilize Concepts and Principles of Fixturing
    a. Determine need for fixture/jig
    b. Design appropriate fixture/jig
    c. Identify components used in fixtures/jigs
    d. Disassemble and assemble fixture/jig
    e. Discuss relationship between accuracy of fixture and accuracy/repeatability of parts
14. Make Calculations For and Use Sine Bar/Sine Plate
    a. Define sine bar/sine plate
    b. Calculate gage block buildup for sine bar/sine plate
    c. Set-up and use sine bar/sine plate

F. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
    a. Read, write, interpret, and apply memorandums
    b. Read, write, interpret, and apply business letters
    c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
    a. Read, write, interpret, and apply technical reports
    b. Read, write, interpret, and apply written procedures
    c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
    a. Demonstrate ability to listen to and understand verbal technical information/instructions
    b. Ask appropriate questions to ascertain needed information
    c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
    a. Create, read, and apply graphs
    b. Create, read, and apply charts
    c. Create, read, and apply graphical illustrations

G. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
    a. List and apply the three primary planes of projection
    b. List and apply the six principle views.
    c. Use and apply auxiliary views
    d. Create/use sectional views

H. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology
2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements From Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*
   1. allocates time to complete assigned tasks on schedule
   2. determines cost associated with meeting objectives
   3. determines and allocates required materials and resources for meeting objectives
   4. evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*
   1. participates as a member of the team, contributing to group effort
   2. provides individual assistance/direction to peers as requested
   3. determines and meets internal and external customers' expectations
   4. exercises leadership qualities to effectively communicate ideas and make decisions

5. negotiates resources in order to accomplish objectives
6. works well with all members of the class

C. ***Information:*** *Acquires and uses information*
1. acquires and evaluates information
2. organizes and maintains information
3. interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*
1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*
1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
   b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. demonstrates ability to understand and perform multi-step computations
   d. demonstrates ability to read, interpret, and use standard measuring devices
   e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations
   b. demonstrates ability to choose and organize appropriate words to effectively communicate
   c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes

e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long-term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. demonstrates ability to identify potential pitfalls and take evasive actions
   e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. demonstrates maturity to take responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternatives or options for problem solution
   d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. demonstrates ability to initiate and effect solution
   f. demonstrates ability to take responsibility for outcomes
   g. demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery
   d. demonstrates ability to visualize abstractly
   e. demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. demonstrates appropriate and acceptable social behaviors in classroom interactions
b. demonstrates ability to work cooperatively in individual, team, or group situations
c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
3. Basic Blueprint Reading and Sketching, Olivo, Olivo, and Payne, Delmar Publishers

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*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

INTRODUCTION TO DIE MAKING PROCEDURES

MAST PROGRAM
COURSE SYLLABUS
INTRODUCTION TO DIE MAKING PROCEDURES

Lecture hours/week: 2 **Lab hours/week: 4** **Credit hours: 4**

COURSE DESCRIPTION:

This course is an introduction to tool and die making procedures including an orientation to metallurgy and die repair. Students are instructed and given practice in the inspection, disassembly, fabrication, and reassembly of die components.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Dies Safety in Handling and Transport	1, 191	

of Dies	------	
Die Terminology and Components	1-5, 192, 193	
Die Operation and Performance	1-21, 51-62	
Part Inspection for Identification of Die Problems	3-6	
Disassembly and Assembly of Die Set	------	
Inspection of Die Set and Die Components	Handout	
Die Block Construction and Repair	97-108	
Die Block Mounting Procedures	Handout	
Construction, Sharpening, and Mounting of Punches	63-86	
Purpose and Construction of Pilots	87-96	
Purpose and Construction of Backing Plates	Handout	
	Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Orientation to Die Sets	2
Safety with Die Sets and in Machine Shop	2
Operation of Die Set in Punch Press	2
Project (Disassembly and Assembly of Die Set)	4
Inspect Die Components	3
Project (Sharpen Die Components)	9
Project (Construction of Die Block)	12
Project (Punch and Pilot)	12
Project (V-Form Die Block)	18
Total Lab Hours	**64**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives
   c. Wear safety/protective equipment as required
2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition
   b. Maintain all guards, shields, and barriers in place and in good condition
   c. Perform preventive maintenance as required
   d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean and free of debris
   b. Keep aisles/traffic areas clear of equipment and materials

c. Store materials, tools, and instruments in organized manner
d. Clean machine/hand tools when work is complete

4. Use Safe Operating Procedures For Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement

c. Determine proper instrument to use in measurement

2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gages
   k. Use Rockwell hardness tester
   l. Use surface plates
3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Identify Materials With Desired Properties
   a. Determine/identify service requirements (strength, hardness, etc.)
   b. Determine, interpret, and evaluate availability of materials
   c. Describe general characteristics of various metals
   d. Know concepts of and calculate statics and stresses
2. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness
   b. Define toughness
   c. Define tensile strength
   d. Define shear strength
   e. Define elasticity
   f. Define ductility

g. Discuss the Rockwell and Brinell hardness scales
h. Discuss the Charpy/Izod impact tests

3. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Discuss cold forming/workability of various materials
   c. Define work hardening/edge hardening
   d. Identify welding properties of various materials
   e. Demonstrate knowledge of heat treating procedures and properties
   f. Know stress relieving procedures
   g. Know/Find hardness characteristics and chemistry of various materials
4. Discuss Classification System for Metals
   a. Identify and discuss types of carbon steel
   b. Determine chemistry of material by classification
   c. Distinguish between SAE and AISI classification systems
   d. Identify designation of each digit of steel classification
   e. Discuss alloy steels

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Calculate speeds and feeds based on materials and tooling
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Calculate speeds and feeds based on materials and tooling
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines
   f. Discuss drilling safety
   g. Calculate speeds and feeds based on materials and tooling
4. Know Operation of Surface and Cylindrical Grinders
   a. Define grinders, surface and cylindrical
   b. Explain types and maintenance of grinding wheels
   c. Set-up and operate grinding machines

d. Explain machine components and accessories of grinding machines
e. Explain grinding processes
f. Discuss grinding safety

5. Know Operation of Heat Treating Equipment and Processes
   a. Describe types of heat treating equipment
   b. Set-up and operate heat treating equipment
   c. Explain machine components and accessories of heat treating equipment
   d. Explain heat treating procedures
   e. Discuss heat treating safety
6. Know Operation of Welding Equipment and Processes
   a. Identify various types of welding equipment
   b. Identify and discuss the difference in welding processes
   c. Inspect welds for cracks and penetration
   d. Discuss welding safety
7. Know Sheet Metal Operations
   a. Discuss gas/plasma cutting equipment and processes
   b. Discuss operation of punch/brake presses and tooling
   c. Discuss operation of plate shears
   d. Discuss fabrication of sheet metal parts
   e. Demonstrate layout-on-metal
   f. Apply conservation-of-material concepts
8. Know Operation of Jig-Boring Machines and Tooling
   a. Define jig-boring machine
   b. List, describe, and give function and maintenance of different types of tooling used on jig-boring machines
   c. Set-up and operate jig-boring machine
   d. Explain machine components and accessories of jig-boring machines
   e. Explain jig-boring process
   f. Discuss safety on jig-boring machine
   g. Calculate speeds and feeds based on materials and tooling
9. Know Operation of Tool and Cutter Grinders
   a. Define tool/cutter grinder
   b. Discuss dressing and maintenance of grinding wheels
   c. Explain machine components and accessories of tool/cutter grinder
   d. Discuss tool and cutter grinder safety
10. Know Operation of Metal Saws
   a. Define band saw, horizontal and vertical
   b. Set-up and operate band saw
   c. Define abrasive cut-off saw
   d. Set-up and operate abrasive cut-off saw
   e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades
   f. Weld and maintain band saw blade
   g. Discuss band saw safety
   h. Calculate speeds and feeds based on materials and tooling
   i. Explain machine components and accessories of band saws
   j. Calculate proper length of band saw blade
11. Estimate Time Required/Cost to Produce a Part

a. Determine processes required to produce part
b. Calculate actual machining and handling time
c. Calculate material quantity and cost
d. Calculate labor and overhead cost

12. Know Proper Flow of Parts Through Shop
    a. Discuss proper order of processes
    b. Discuss ergonomic aspects of plant layout
13. Utilize Concepts and Principles of Fixturing
    a. Determine need for fixture/jig
    b. Design appropriate fixture/jig
    c. Identify components used in fixtures/jigs
    d. Disassemble and assemble fixture/jig
    e. Discuss relationship between accuracy of fixture and accuracy/repeatability of parts
14. Make Calculations For and Use Sine Bar/Sine Plate
    a. Define sine bar/sine plate
    b. Calculate gage block buildup for sine bar/sine plate
    c. Set-up and use sine bar/sine plate

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    b. Ask appropriate questions to ascertain needed information
    c. Demonstrate ability to give verbal technical information/instructions
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    a. Create, read, and apply graphs
    b. Create, read, and apply charts
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G. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
    a. List and apply the three primary planes of projection
    b. List and apply the six principle views
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    a. Distinguish between general and specific notes
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    c. Determine and apply dimensions on a drawing
    d. Identify basic symbols found on a drawing

e. Identify tolerances on a drawing
f. Discuss GD&T methodology

2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements From Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

I. PERFORM DIE OPERATIONS

1. Utilize Basic Die Theory
   a. Define/calculate proper shut-height of die set
   b. Determine die feed direction
   c. Explain notch, pierce, pilot, form, and cut-off stations
   d. Determine stop block length
   e. Define/calculate slug clearance
   f. Explain operation of die set to make piece part
   g. Explain bending action in V-form dies
   h. Identify components of die set
   i. Discuss materials of die components
2. Perform Die Repair
   a. Disassemble and assemble die set
   b. Visually inspect die components for damage
   c. Identify component parts to be repaired/sharpened
   d. Determine method of repairing/sharpening
   e. Determine material for replacement parts
   f. Manufacture replacement parts
   g. Demonstrate setting correct punch entry
3. Demonstrate Die Making Skills
   a. Identify component parts from die blueprint
   b. Determine material/purchased parts requirements
   c. Utilize die making procedures to make component parts
   d. Utilize die making procedures to mount component parts
   e. Demonstrate mounting of die set in press machine
   f. Cycle die set in press machine and inspect operation
   g. Inspect piece part for accuracy

COURSE OBJECTIVES: SCANS COMPETENCIES

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competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

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I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources

1. allocates time to complete assigned tasks on schedule
2. determines cost associated with meeting objectives
3. determines and allocates required materials and resources for meeting objectives
4. evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others

1. participates as a member of the team, contributing to group effort
2. provides individual assistance/direction to peers as requested
3. determines and meets internal and external customers' expectations
4. exercises leadership qualities to effectively communicate ideas and make decisions
5. negotiates resources in order to accomplish objectives
6. works well with all members of the class

C. Information: Acquires and uses information

1. acquires and evaluates information
2. organizes and maintains information
3. interprets and communicates information

D. Systems: Understands complex inter-relationships

1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks.

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and

supplemental materials on a level to facilitate productive independent and group study

c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments.
3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
   b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. demonstrates ability to understand and perform multi-step computations
   d. demonstrates ability to read, interpret, and use standard measuring devices
   e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*

a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. demonstrates ability to hear, comprehend, and appropriately follow directions
c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
a. demonstrates appropriate listening and speaking skills in personal conversations
b. demonstrates ability to choose and organize appropriate words to effectively communicate
c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. demonstrates ability to objectively assess personal strengths and weaknesses
b. demonstrates ability to set realistic short-term and long-term goals
c. demonstrates ability to recognize and distinguish between positive and negative alternatives
d. demonstrates ability to identify potential pitfalls and take evasive actions
e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. demonstrates maturity to take responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. demonstrates ability to detect problem through observation, inquiry, or directive
b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. demonstrates ability to generate alternatives or options for problem solution
d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. demonstrates ability to initiate and effect solution
f. demonstrates ability to take responsibility for outcomes
g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery
   d. demonstrates ability to visualize abstractly
   e. demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. demonstrates ability to focus on task at hand and work to completion
d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. demonstrates maturity to take responsibility for actions
f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions

d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Die Design Fundamentals, J.R. Pacquin and R.E. Crowley, 2nd Ed.

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*T*echnology Program

MAST

COURSE SYLLABUS

FUNDAMENTALS OF DRAFTING

MAST PROGRAM
COURSE SYLLABUS
FUNDAMENTALS OF DRAFTING

Lecture hours/week: 2 **Lab hours/week: 2** **Credit hours: 3**

COURSE DESCRIPTION:

This course is designed to give basic information related to instruments, equipment, principles and techniques used in drafting. Emphasis is placed on drafting conventional practices.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Technical Drawing, Giesecke, Mitchell, Spencer, Hill, Dygdon, Novack, McMillan., 9th Ed.

Lab Manual: Instructions for Lettering With Practice Sheets

Hand Tools/Quantity Required:

Triangular Architect's Scale	1
Triangular Engineer's Scale	1
45° Triangle (8" sides)	1
30° X 60° Triangle (10" long side)	1
Ames Lettering Guide or Lettering Triangle	1
Irregular Curve	1
Protractor	1
Mechanical Pencils and HB, F, and 2H Lead	1
Pencil Eraser	1
Eraser Shield	1
Dusting Brush	1
Drafting Tape	1
Circle Template	1
Compass	1
Dividers	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all lab rules and safety regulations

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Drafting	1-11	
Lettering	63-86	
Drafting Instruments	13-62	
Geometric Constructions	87-124	
Engineering Drawing Concepts	125-202	
Dimensioning	297-356	
Auxiliary Views	229-252	
Sectional Views	203-228	
	Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Lab Orientation and Safety	1
Lettering Techniques	2
Identification and Nomenclature of Instruments	1
Sketching Exercises	2
Drafting Machine Exercises (Geometric Construction)	2
Project (Missing View Problems - pp 185-187)	2
Project (Safety Key - Fig. 6.53; Pg 188)	2
Project (Index Feed - Fig. 6.58; Pg 188)	2
Project (Holder Clip - Fig. 6.60; Pg 189)	3
Project (Index Arm - Fig. 6.62; Pg 189)	3
Project (Cross-Feed Stop - Fig. 6.74; Pg 191)	3
Project (Tool Holder - Fig. 6.56; Pg 188)	3
Project (Anchor Bracket - Fig. 6.88; Pg 193)	3
Project (Control Bracket - Fig. 8.41; Pg 248)	3
Total Lab Hours	**32**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers

b. Add, subtract, multiply, and divide fractions
c. Add, subtract, multiply, and divide decimals
d. Interconvert fractions/decimals
e. Interconvert metric/English measurements

2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use Basic Geometric Principles
   a. Solve for surface area, perimeter, and volume of cube
   b. Solve for surface area, perimeter, and volume of rectangular solid
   c. Solve for surface area, perimeter, and volume of right triangular solid
   d. Solve for surface area, perimeter, and volume of cylinder
   e. Find diagonal of a square

B. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
   a. Read, write, interpret, and apply memorandums
   b. Read, write, interpret, and apply business letters
   c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
   a. Read, write, interpret, and apply technical reports
   b. Read, write, interpret, and apply written procedures
   c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
   a. Demonstrate ability to listen to and understand verbal technical information/instructions
   b. Ask appropriate questions to ascertain needed information
   c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
   a. Create, read, and apply graphs
   b. Create, read, and apply charts
   c. Create, read, and apply graphical illustrations

C. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
   a. Demonstrate use of drafting machine and instruments
   b. Demonstrate drafting technique to create basic geometric elements
   c. Demonstrate isometric sketching of objects
   d. List and apply the three primary planes of projection
   e. List and apply the six principle views.
   f. Use and apply auxiliary views
   g. Create sectional views
2. Use and Apply Geometric Dimensioning and Tolerancing (GD&T) Methodology

a. Distinguish between conventional and geometric dimensioning and tolerancing.
b. Explain and use geometric positional tolerancing
c. Explain and use tolerances of form
d. Explain and use the feature control symbol
e. Explain and use modifiers in geometric dimensioning and tolerancing

D. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology
2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources

1. allocates time to complete assigned tasks on schedule
2. determines and allocates required materials and resources for meeting objectives
3. evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*
   1. participates as a member of the team, contributing to group effort
   2. provides individual assistance/direction to peers as requested
   3. determines and meets internal and external customers' expectations
   4. exercises leadership qualities to effectively communicate ideas and make decisions.
   5. negotiates resources in order to accomplish objectives
   6. works well with all members of the class

C. *Information: Acquires and uses information*
   1. acquires and evaluates information
   2. organizes and maintains information
   3. interprets and communicates information

D. *Systems: Understands complex inter-relationships*
   1. understands and works well with social, organizational, and technological systems
   2. monitors and corrects performance of system during operation
   3. recommend modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
   1. chooses relevant procedures, tools and equipment
   2. applies appropriate procedures and techniques to accomplish tasks
   3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. ***Basic Skills:*** Reads, writes, performs arithmetic and mathematical operations, listens and speaks.

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
   b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. demonstrates ability to understand and perform multi-step computations
   d. demonstrates ability to read, interpret, and use standard measuring devices
   e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations

b. demonstrates ability to choose and organize appropriate words to effectively communicate
c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long-term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. demonstrates ability to identify potential pitfalls and take evasive actions
   e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. demonstrates maturity to take responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternatives or options for problem solution
   d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. demonstrates ability to initiate and effect solution
   d. demonstrates ability to take responsibility for outcomes
   g. demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. demonstrates ability to visually discriminate in gross and fine imagery
d. demonstrates ability to visualize abstractly
e. demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors

c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. demonstrates ability to accept and use constructive criticism
f. accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

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*T*echnology Program

MAST

COURSE SYLLABUS

INTRODUCTION TO COMPUTERS

MAST PROGRAM
COURSE SYLLABUS
INTRODUCTION TO COMPUTERS

Lecture hours/week: 2 **Lab hours/week: 2** **Credit hours: 3**

COURSE DESCRIPTION:

This course is designed to give the student an introduction to computer terminology and information processing concepts including operating systems, word processing, spreadsheets, data management, graphics, and BASIC programming.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: **None**
Lab Manual: **Provided by Instructor**

Hand Tools/Quantity Required:
3 ½" Data Diskette

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all lab rules and safety regulations

TENTATIVE LECTURE OUTLINE:

Lecture Topic	Text Reference Page	Contact Hrs.
Introduction to Computers Hardware and Software		

Hardware Components and Terminology
Computer Operating Systems
Directory Structure and File Management
Word Processing Software
Spreadsheet Software
Databases
Using Peripheral Devices
Backup and Restore Functions
Installation of Software
Introduction to Use of Networking

Total Lecture Hours **32**

TENTATIVE LAB OUTLINE:

Lab Topics	Contact Hrs.
Lab Orientation and Safety	1
Demonstration of Hardware	2
Use Computer Operating Systems	2
Create Directories and Save Files	2
Create Document using Word Processor Software	4
Create Spreadsheet	4
Create Database	6
Printing (in each software program and DOS)	3
Perform Backup and Restore of Selected Files	3
Install Software	3
Log in to Network	2
Total Lab Hours	**32**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
   a. Read, write, interpret, and apply memorandums
   b. Read, write, interpret, and apply business letters
   c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
   a. Read, write, interpret, and apply technical reports
   b. Read, write, interpret, and apply written procedures
   c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
   a. Demonstrate ability to listen to and understand verbal technical information/instructions
   b. Ask appropriate questions to ascertain needed information
   c. Demonstrate ability to give verbal technical information/instructions

4. Use Graphics for Visual Aid
   a. Create, read, and apply graphs
   b. Create, read, and apply charts
   c. Create, read, and apply graphical illustrations

B. USE COMPUTERS

1. Use Computer Operating Systems
   a. Explain the phrase "IBM compatible"
   b. Use DOS operating system/DOS commands
   c. Use Windows
   d. Use computer network system
2. Use File Management Systems
   a. Discuss file management concepts
   b. Create/remove directories
   c. Copy files from floppy disks to hard drive
3. Perform Backup on a Personal Computer
   a. Discuss need to backup hard disk
   b. Perform complete backup of hard disk
   c. Perform backup of selected files and directories
   d. Restore backup set to hard disk
   e. Discuss need for/make system disk
4. Install/Use Software Packages
   a. Install software package to hard disk
   b. Configure system parameters for software package
   c. Use word processor software (WordPerfect, MS Word)
   d. Use spreadsheet software (Lotus, MS Excel)
5. Understand and Apply Computer Terminology
   a. Define Read Only Memory (ROM)
   b. Define Random Access Memory (RAM)
   c. Define cache memory
   d. Define byte, kilobyte, megabyte
   e. Define Central Processing Unit (CPU)
   f. Discuss processor speed
   g. Understand RS-232 protocol

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*
   1. allocates time to complete assigned tasks on schedule
   2. determines and allocates required materials and resources for meeting objectives.
   3. evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal: Works with others***
   1. participates as a member of the team, contributing to group effort
   2. provides individual assistance/direction to peers as requested
   3. determines and meets internal and external customers' expectations
   4. exercises leadership qualities to effectively communicate ideas and make decisions
   5. negotiates resources in order to accomplish objectives
   6. works well with all members of the class

C. ***Information: Acquires and uses information***
   1. acquires and evaluates information
   2. organizes and maintains information
   3. interprets and communicates information

D. ***Systems: Understands complex inter-relationships***
   1. understands and works well with social, organizational, and technological systems
   2. monitors and corrects performance of system during operation
   3. recommend modifications to system to improve performance

E. ***Technology: Works with a variety of technologies***
   1. chooses relevant procedures, tools and equipment
   2. applies appropriate procedures and techniques to accomplish tasks
   3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. *Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*
   1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules
      a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
   b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. demonstrates ability to understand and perform multi-step computations
   d. demonstrates ability to read, interpret, and use standard measuring devices
   e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations
   b. demonstrates ability to choose and organize appropriate words to effectively communicate
   c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and. /or assessment purposes
   e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long-term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. demonstrates ability to identify potential pitfalls and take evasive actions
   e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. demonstrates maturity to take responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternatives or options for problem solution
   d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. demonstrates ability to initiate and effect solution
   f. demonstrates ability to take responsibility for outcomes

g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery
   d. demonstrates ability to visualize abstractly
   e. demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

DIE DESIGN I

Prerequisite: INTRODUCTION TO DIE MAKING PROCEDURES

MAST PROGRAM
COURSE SYLLABUS
DIE DESIGN I

Lecture hours/week: 2 **Lab hours/week: 2** **Credit hours: 3**

COURSE DESCRIPTION:

This course is an introduction to the design of industrial dies and the machining characteristics of die components. This course serves as a continuation of Introduction to Die Making Procedures and Machine Tool Technology. The student is introduced to additional machining skills that will be encountered in typical die shops in the building of dies, jigs, fixtures, and precision machine parts.

PREREQUISITES: **Machine Tool Technology and Introduction to Die Making Procedures**

REQUIRED COURSE MATERIALS:

Textbook:
(1) Technology of Machine Tools, Krar, Oswald, St. Amand, McGraw-Hill., 4th Ed.
(2) Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill.

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Die and Fixture Design	------	
Safety in a Die Shop	Handout	
Stampings Design	Handout	
Die Engineering - Planning and Design	(2) 1-5, 192, 193, HO	
Special Characteristics of Die Components	------	
Special Milling Operations	(1) 350-391	
Tool and Cutter Grinder	(1) 520-531	
Indexing or Dividing Head	(1) 350-362	
Special Grinding Operations	(1) 503-519	
Special Turning Operations	(1) 244-306	
Punch and Die Shoe Construction	(2) 63-86	
Sine Bar and Vises	(1) 71-74	
Construction of V-Dies	(2) 23-31	
Hardness Testing of Metal	(1) 566-602, HO	—
	Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction to the Design of Dies	1
Safety in the Die Shop	1
Visual Survey of Stampings	1
Project (Mill T-Slot and Dovetail in Block)	3
Project (Grind Radius Tool)	3
Project (Mill Convex and Concave Radius in Block)	3
Project (Grind Radius Tool)	6
Project (Dress Grinding Wheel)	2
Project (Grind Radius on Block)	2
Project (Tapered Punch)	4
Project (V-Die Block)	6
Total Lab Hours	**32**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives
   c. Wear safety/protective equipment as required
2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition

b. Maintain all guards, shields, and barriers in place and in good condition
c. Perform preventive maintenance as required
d. Practice proper tag-out/lock-out procedures

3. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean and free of debris
   b. Keep aisles/traffic areas clear of equipment and materials
   c. Store materials, tools, and instruments in organized manner
   d. Clean machine/hand tools when work is complete
4. Use Safe Operating Procedures for Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use and Apply Cartesian Coordinate System

a. Define the Cartesian coordinate system
b. Plot machining points using Cartesian coordinate system

C. **DEMONSTRATE QUALITY CONTROL AND MANAGEMENT**

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gages
   k. Use Rockwell hardness tester
   l. Use surface plates
3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. **DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS**

1. Identify Materials with Desired Properties
   a. Determine/identify service requirements (strength, hardness, etc.)
   b. Determine, interpret, and evaluate availability of materials
   c. Describe general characteristics of various metals
   d. Know concepts of and calculate statics and stresses
2. Demonstrate Knowledge of Physical Properties of Materials

a. Define hardness
b. Define toughness
c. Define tensile strength
d. Define shear strength
e. Define elasticity
f. Define ductility
g. Discuss the Rockwell and Brinell hardness scales
h. Discuss the Charpy/Izod impact tests

3. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Discuss cold forming/workability of various materials
   c. Define work hardening/edge hardening
   d. Identify welding properties of various materials
   e. Demonstrate knowledge of heat treating procedures and properties
   f. Know stress relieving procedures
   g. Know/Find hardness characteristics and chemistry of various materials
4. Discuss Classification System for Metals
   a. Identify and discuss types of carbon steel
   b. Determine chemistry of material by classification
   c. Distinguish between SAE and AISI classification systems
   d. Identify designation of each digit of steel classification
   e. Discuss alloy steels

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Calculate speeds and feeds based on materials and tooling
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Calculate speeds and feeds based on materials and tooling
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines

f. Discuss drilling safety
g. Calculate speeds and feeds based on materials and tooling

4. Know Operation of Surface and Cylindrical Grinders
   a. Define grinders, surface and cylindrical
   b. Explain types and maintenance of grinding wheels
   c. Set-up and operate grinding machines
   d. Explain machine components and accessories of grinding machines
   e. Explain grinding processes
   f. Discuss grinding safety
5. Know Operation of Heat Treating Equipment and Processes
   a. Describe types of heat treating equipment
   b. Set-up and operate heat treating equipment
   c. Explain machine components and accessories of heat treating equipment
   d. Explain heat treating procedures
   e. Discuss heat treating safety
6. Know Operation of Welding Equipment and Processes
   a. Identify various types of welding equipment
   b. Identify and discuss the difference in welding processes
   c. Inspect welds for cracks and penetration
   d. Discuss welding safety
7. Know Sheet Metal Operations
   a. Discuss gas/plasma cutting equipment and processes
   b. Discuss operation of punch/brake presses and tooling
   c. Discuss operation of plate shears
   d. Calculate tonnages required for press/shear operations
   e. Calculate blank dimensions of developed parts
   f. Use yield tables for bending sheet metal
   g. Discuss fabrication of sheet metal parts
   h. Demonstrate layout-on-metal
   i. Apply conservation-of-material concepts
8. Know Operation of Jig-boring Machines and Tooling
   a. Define jig-boring machine
   b. List, describe, and give function and maintenance of different types of tooling used on jig-boring machines
   c. Set-up and operate jig-boring machine
   d. Explain machine components and accessories of jig-boring machines
   e. Explain jig-boring process
   f. Discuss safety on jig-boring machine
   g. Calculate speeds and feeds based on materials and tooling
9. Know Operation of Tool and Cutter Grinders
   a. Define tool/cutter grinder
   b. Discuss dressing and maintenance of grinding wheels
   c. Explain machine components and accessories of tool/cutter grinder
   d. Discuss tool and cutter grinder safety
10. Know Operation of Metal Saws
   a. Define band saw, horizontal and vertical
   b. Set-up and operate band saw
   c. Define abrasive cut-off saw

d. Set-up and operate abrasive cut-off saw
e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades
f. Weld and maintain band saw blade
g. Discuss band saw safety
h. Calculate speeds and feeds based on materials and tooling
i. Explain machine components and accessories of band saws
j. Calculate proper length of band saw blade

11. Estimate Time Required/cost to Produce a Part
    a. Determine processes required to produce part
    b. Calculate actual machining and handling time
    c. Calculate material quantity and cost
    d. Calculate labor and overhead cost
12. Know Proper Flow of Parts Through Shop
    a. Discuss proper order of processes
    b. Discuss ergonomic aspects of plant layout
13. Utilize Concepts and Principles of Fixturing
    a. Determine need for fixture/jig
    b. Design appropriate fixture/jig
    c. Identify components used in fixtures/jigs
    d. Disassemble and assemble fixture/jig
    e. Discuss relationship between accuracy of fixture and accuracy/repeatability of parts
14. Make Calculations for and Use Sine Bar/Sine Plate
    a. Define sine bar/sine plate
    b. Calculate gage block buildup for sine bar/sine plate
    c. Set-up and use sine bar/sine plate
15. Make Calculations for and Use Rotary Table and Dividing Head
    a. Set-up and use rotary table/dividing head for machining operations
    b. Make calculations for number of rotations required
    c. Determine/select appropriate index plate for dividing head

F. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
    a. Read, write, interpret, and apply memorandums
    b. Read, write, interpret, and apply business letters
    c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
    a. Read, write, interpret, and apply technical reports
    b. Read, write, interpret, and apply written procedures
    c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
    a. Demonstrate ability to listen to and understand verbal technical information/instructions
    b. Ask appropriate questions to ascertain needed information
    c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
    a. Create, read, and apply graphs
    b. Create, read, and apply charts

c. Create, read, and apply graphical illustrations

G. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
   a. List and apply the three primary planes of projection
   b. List and apply the six principle views.
   c. Use and apply auxiliary views
   d. Create/use sectional views

H. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology
2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

I. PERFORM DIE OPERATIONS

1. Demonstrate Die Making Skills
   a. Identify component parts from die blueprint
   b. Determine material/purchased parts requirements
   c. Utilize die making procedures to make component parts
   d. Utilize die making procedures to mount component parts
   e. Inspect piece part for accuracy

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2. determines cost associated with meeting objectives
3. determines and allocates required materials and resources for meeting objectives
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B. ***Interpersonal:*** *Works with others*

1. participates as a member of the team, contributing to group effort
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1. acquires and evaluates information
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1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
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1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
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II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

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   c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
   b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. demonstrates ability to understand and perform multi-step computations
   d. demonstrates ability to read, interpret, and use standard measuring devices
   e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations
   b. demonstrates ability to choose and organize appropriate words to effectively communicate
   c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and/or assessment purposes
   e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. demonstrates ability to identify potential pitfalls and take evasive actions
   e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. demonstrates maturity to take responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternative or options for problem solution

d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. demonstrates ability to initiate and effect solution
f. demonstrates ability to take responsibility for outcomes
g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and at upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery
   d. demonstrates ability to visualize abstractly
   e. demonstrates ability to apply visual imagery to applied tasks
4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. *Personal Qualities: Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion

d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. demonstrates maturity to take responsibility for actions
f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty ad integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Die Design Fundamentals, J.R. Pacquin and R.E. Crowley, 2nd Ed.
3. Student's Shop Reference Handbook, Edward G. Hoffman

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*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

DIE MAKING I

Prerequisite: INTRODUCTION TO DIE MAKING PROCEDURES

MAST PROGRAM
COURSE SYLLABUS
DIE MAKING I

Lecture hours/week: 3 **Lab hours/week: 6** **Credit hours: 6**

COURSE DESCRIPTION:

This course is a continuation of Introduction to Die Making Procedures with instruction and practice in building a complete functional die from a blueprint. Emphasis is placed on analyzing requirements, managing the project toward completion, and becoming proficient in shop practices and procedures.

PREREQUISITES: **Introduction to Die Making Procedures**

REQUIRED COURSE MATERIALS:

Textbook: Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Die Building	------	
Safety in the Die Shop	------	
The Die Blueprint	Handout	
Component Requirements	Handout	
Material Requirements and Specifications	Handout	
Planning Machining Events	51-57, 97-108, HO	
Importance of Inspection and Accuracy	Handout	
The Die Shoes, Guide Posts and Bushings	193, HO	
Die Block Construction	97-108, HO	
Calculations for V-Form Dies	23-50, HO	
Heat Treatment of Die Components	Handout	
Mounting Procedures	Handout	
Overview of the Punch Press		
	Total Lecture Hours	**48**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Orientation and Safety	2
Material Inventory	2
Material Requisitioning for V-Form Die	2
Project (V-Form Die)	84
Tryout of V-Form Die	6
Total Lab Hours	**96**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives
   c. Wear safety/protective equipment as required
2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition
   b. Maintain all guards, shields, and barriers in place and in good condition
   c. Perform preventive maintenance as required
   d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment

a. Keep work areas clean and free of debris
b. Keep isles/traffic areas clear of equipment and materials
c. Store materials, tools, and instruments in organized manner
d. Clean machine/hand tools when work is complete

4. Use Safe Operating Procedures for Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gages
   k. Use Rockwell hardness tester
   l. Use surface plates
3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Identify Materials with Desired Properties
   a. Determine/identify service requirements (strength, hardness, etc.)
   b. Determine, interpret, and evaluate availability of materials
   c. Describe general characteristics of various metals
   d. Know concepts of and calculate statics and stresses
2. Demonstrate Knowledge of Physical Properties of Materials

a. Define hardness
b. Define toughness
c. Define tensile strength
d. Define shear strength
e. Define elasticity
f. Define ductility
g. Discuss the Rockwell and Brinell hardness scales
h. Discuss the Charpy/Izod impact tests

3. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Discuss cold forming/workability of various materials
   c. Define work hardening/edge hardening
   d. Identify welding properties of various materials
   e. Demonstrate knowledge of heat treating procedures and properties
   f. Know stress relieving procedures
   g. Know/Find hardness characteristics and chemistry of various materials
4. Discuss Classification System for Metals
   a. Identify and discuss types of carbon steel
   b. Determine chemistry of material by classification
   c. Distinguish between SAE and AISI classification systems
   d. Identify designation of each digit of steel classification
   e. Discuss alloy steels

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Calculate speeds and feeds based on materials and tooling
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Calculate speeds and feeds based on materials and tooling
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines

d. Explain machine components and accessories of drilling machines
e. Explain processes performed on drilling machines
f. Discuss drilling safety
g. Calculate speeds and feeds based on materials and tooling

4. Know Operation of Surface and Cylindrical Grinders
   a. Define grinders, surface and cylindrical
   b. Explain types and maintenance of grinding wheels
   c. Set-up and operate grinding machines
   d. Explain machine components and accessories of grinding machines
   e. Explain grinding processes
   f. Discuss grinding safety
5. Know Operation of Heat Treating Equipment and Processes
   a. Describe types of heat treating equipment
   b. Set-up and operate heat treating equipment
   c. Explain machine components and accessories of heat treating equipment
   d. Explain heat treating procedures
   e. Discuss heat treating safety
6. Know Operation of Welding Equipment and Processes
   a. Identify various types of welding equipment
   b. Identify and discuss the difference in welding processes
   c. Inspect welds for cracks and penetration
   d. Discuss welding safety
7. Know Sheet Metal Operations
   a. Discuss gas/plasma cutting equipment and processes
   b. Discuss operation of punch/brake presses and tooling
   c. Discuss operation of plate shears
   d. Calculate tonnages required for press/shear operations
   e. Calculate blank dimensions of developed parts
   f. Use yield tables for bending sheet metal
   g. Discuss fabrication of sheet metal parts
   h. Demonstrate layout-on-metal
   i. Apply conservation-of-material concepts
8. Know Operation of Jig-boring Machines and Tooling
   a. Define jig-boring machine
   b. List, describe, and give function and maintenance of different types of tooling used on jig-boring machines
   c. Set-up and operate jig-boring machine
   d. Explain machine components and accessories of jig-boring machines
   e. Explain jig-boring process
   f. Discuss safety on jig-boring machine
   g. Calculate speeds and feeds based on materials and tooling
9. Know Operation of Tool and Cutter Grinders
   a. Define tool/cutter grinder
   b. Discuss dressing and maintenance of grinding wheels
   c. Explain machine components and accessories of tool/cutter grinder
   d. Discuss tool and cutter grinder safety

10. Know Operation of Metal Saws
    a. Define band saw, horizontal and vertical
    b. Set-up and operate band saw
    c. Define abrasive cut-off saw
    d. Set-up and operate abrasive cut-off saw
    e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades
    f. Weld and maintain band saw blade
    g. Discuss band saw safety
    h. Calculate speeds and feeds based on materials and tooling
    i. Explain machine components and accessories of band saws
    j. Calculate proper length of band saw blade
11. Estimate Time Required/Cost to Produce a Part
    a. Determine processes required to produce part
    b. Calculate actual machining and handling time
    c. Calculate material quantity and cost
    d. Calculate labor and overhead cost
12. Know Proper Flow of Parts Through Shop
    a. Discuss proper order of processes
    b. Discuss ergonomic aspects of plant layout
13. Utilize Concepts and Principles of Fixturing
    a. Determine need for fixture/jig
    b. Design appropriate fixture/jig
    c. Identify components used in fixtures/jigs
    d. Disassemble and assemble fixture/jig
    e. Discuss relationship between accuracy of fixture and accuracy/ repeatability of parts
14. Make Calculations for and Use Sine Bar/Sine Plate
    a. Define sine bar/sine plate
    b. Calculate gage block buildup for sine bar/sine plate
    c. Set-up and use sine bar/sine plate
15. Make Calculations for and Use Rotary Table and Dividing Head
    a. Set-up and use rotary table/dividing head for machining operations
    b. Make calculations for number of rotations required
    c. Determine/select appropriate index plate for dividing head

F. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
    a. Read, write, interpret, and apply memorandums
    b. Read, write, interpret, and apply business letters
    c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
    a. Read, write, interpret, and apply technical reports
    b. Read, write, interpret, and apply written procedures
    c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally

a. Demonstrate ability to listen to and understand verbal technical information/instructions
b. Ask appropriate questions to ascertain needed information
c. Demonstrate ability to give verbal technical information/instructions

4. Use Graphics for Visual Aid
   a. Create, read, and apply graphs
   b. Create, read, and apply charts
   c. Create, read, and apply graphical illustrations

G. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
   a. List and apply the three primary planes of projection
   b. List and apply the six principle views
   c. Use and apply auxiliary views
   d. Create/use sectional views

H. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology
2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

I. PERFORM DIE OPERATIONS

1. Utilize Basic Die Theory
   a. Define/calculate cutting clearance
   b. Define/calculate proper shut-height of die set
   c. Determine die feed direction
   d. Explain notch, pierce, pilot, form, and cut-off stations
   e. Determine stop block length
   f. Define/calculate slug clearance
   g. Explain operation of die set to make piece part
   h. Identify components of die set
   i. Discuss materials of die components

2. Perform Die Repair
   a. Disassemble and assemble die set
   b. Visually inspect die components for damage
   c. Identify component parts to be repaired/sharpened
   d. Determine method of repairing/sharpening
   e. Determine material for replacement parts
   f. Manufacture replacement parts
   g. Demonstrate setting correct punch entry
3. Demonstrate Die Making Skills
   a. Identify component parts from die blueprint
   b. Determine material/purchased parts requirements
   c. Utilize die making procedures to make component parts
   d. Utilize die making procedures to mount component parts
   e. Demonstrate mounting of die set in press machine
   f. Cycle die set in press machine and inspect operation
   g. Inspect piece part for accuracy

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all high school students must develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources
   1. allocates time to complete assigned tasks on schedule
   2. determines cost associated with meeting objectives
   3. determines and allocates required materials and resources for meeting objectives
   4. evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others
   1. participates as a member of the team, contributing to group effort
   2. provides individual assistance/direction to peers as requested
   3. determines and meets internal and external customers' expectations
   4. exercises leadership qualities to effectively communicate ideas and make decisions
   5. negotiates resources in order to accomplish objectives
   6. works well with all members of the class

C. ***Information:*** *Acquires and uses information*
   1. acquires and evaluates information
   2. organizes and maintains information
   3. interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*
   1. understands and works well with social, organizational, and technological systems
   2. monitors and corrects performance of system during operation
   3. recommend modifications to system to improve performance

E. ***Technology***: *Works with a variety of technologies*
   1. chooses relevant procedures, tools and equipment
   2. applies appropriate procedures and techniques to accomplish tasks
   3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
      b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
      c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
      d. demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
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4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
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   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
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5. *Speaking: Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations.
   b. demonstrates ability to choose and organize appropriate words to effectively communicate
   c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.

1. Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative

a. demonstrates ability to objectively assess personal strengths and weaknesses
b. demonstrates ability to set realistic short-term and long-term goals
c. demonstrates ability to recognize and distinguish between positive and negative alternatives
d. demonstrates ability to identify potential pitfalls and take evasive actions
e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. demonstrates maturity to take responsibility for decisions

2. Problem Solving: Recognizes problems and devises and implements plan of action

a. demonstrates ability to detect problem through observation, inquiry, or directive
b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. demonstrates ability to generate alternatives or options for problem solution
d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. demonstrates ability to initiate and effect solution
f. demonstrates ability to take responsibility for outcomes
g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information

a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. demonstrates ability to visually discriminate in gross and fine imagery
d. demonstrates ability to visualize abstractly
e. demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors

c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. demonstrates ability to accept and use constructive criticism
f. accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Die Design Fundamentals, J. R. Pacquin and R.E. Crowley, 2nd Ed.

TDT 1146
01/081496

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

COMPUTER NUMERICAL CONTROL OPERATIONS I

Prerequisite: MACHINE TOOL TECHNOLOGY

MAST PROGRAM
COURSE SYLLABUS
COMPUTER NUMERICAL CONTROL OPERATIONS I

Lecture hours/week: 2 **Lab hours/week: 2** **Credit hours: 3**

COURSE DESCRIPTION:

This course is an introduction to computer numerical control machines. Included is instruction and practice related to the use of the Cartesian coordinate system, programming codes and styles, and operation of basic CNC machines.

PREREQUISITES: **Machine Tool Technology**

REQUIRED COURSE MATERIALS:

Textbook: An Introduction to CNC Machining and Programming, David Gibbs and Thomas M. Crandell, Industrial Press

Lab Manual: Instructor Provided Materials

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Orientation to CNC Machines	1-40	

Safety with CNC Equipment	------
CNC versus Conventional Machining	152-161, HO
Cartesian Coordinate System	Handout
Introduction to CNC Lathe (Training Lathe)	Handout
Planning Turning Operations	152-308, HO
Basic Program Structure	Handout
Manual Data Input	95,96, HO
Tool Positioning and Offsets	41-77, HO
Introduction to CNC Mill (Training Mill)	Handout
Planning CNC Milling Operations	152-308
Basic Program Structure	Handout
Tool Positioning, Offsets, and Registers	41-77, HO
Magnetic and Paper Tape Operation	95-115, HO
Introduction to Direct Numerical Control (DNC)	Handout
Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction to CNC Machines and Safety	2
Demonstration of CNC Equipment	2
Operation of CNC Training Lathe	2
Project (Turn and Journal Shaft)	3
Project (Turn Part with Radii, Angles, and Grooves)	3
Project (Threaded Shaft)	3
Operation of CNC Training Mill	2
Project (Drilled Plate)	3
Project (Milled Plate)	3
Entering Data via Magnetic or Paper Tape	1
Project (Plexi-glass Nameplate)	3
Entering Data via DNC	1
Project (Milled Plate with Pocket and Name)	4
Total Lab Hours	**32**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/ Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives
   c. Wear safety/protective equipment as required
2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition

b. Maintain all guards, shields, and barriers in place and in good condition
c. Perform preventive maintenance as required
d. Practice proper tag-out/lock-out procedures

3. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean and free of debris
   b. Keep isles/traffic areas clear of equipment and materials
   c. Store materials, tools, and instruments in organized manner
   d. Clean machine/hand tools when work is complete
4. Use Safe Operating Procedures for Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system

b. Calculate coordinates of bolt circle on Cartesian coordinate system
c. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gages
   k. Use Rockwell hardness tester
   l. Use surface plates
3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness
   b. Define toughness
2. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Define work hardening/edge hardening

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Discuss CNC machining centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC machining center
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Discuss CNC turning centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC turning center
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines
   f. Discuss drilling safety
   g. Discuss drilling operations on CNC drilling machines
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC drilling machine
4. Estimate Time Required/Cost to Produce a Part
   a. Determine processes required to produce part
   b. Calculate actual machining and handling time
   c. Calculate material quantity and cost
   d. Calculate labor and overhead cost
5. Know Proper Flow of Parts Through Shop
   a. Discuss proper order of processes
   b. Discuss ergonomic aspects of plant layout
6. Utilize Concepts and Principles of Fixturing
   a. Determine need for fixture/jig
   b. Design appropriate fixture/jig
   c. Identify components used in fixtures/jigs
   d. Disassemble and assemble fixture/jig
   e. Discuss relationship between accuracy of fixture and accuracy/ repeatability of parts

F. PERFORM CNC PROGRAMMING/CAM TASKS

1. Prepare and Plan for CNC Machining Operations
   a. Plan sequence of machining events
   b. Determine proper tooling/fixtures required for machining
   c. Calculate speeds, feeds, and depth-of-cut for machining
   d. Explain the x, y, and z axis on CNC machines
2. Manually Program CNC Machines
   a. Plan and write programs for CNC machines
   b. Use MDI panel on machine to program/edit programs
   c. Set and use tooling offsets at CNC machine

G. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
   a. Read, write, interpret, and apply memorandums
   b. Read, write, interpret, and apply business letters
   c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
   a. Read, write, interpret, and apply technical reports
   b. Read, write, interpret, and apply written procedures
   c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
   a. Demonstrate ability to listen to and understand verbal technical information/instructions
   b. Ask appropriate questions to ascertain needed information
   c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
   a. Create, read, and apply graphs
   b. Create, read, and apply charts
   c. Create, read, and apply graphical illustrations

H. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
   a. List and apply the three primary planes of projection
   b. List and apply the six principle views.
   c. Use and apply auxiliary views
   d. Create/use sectional views

I. USE COMPUTERS

1. Use Computer Operating Systems
   a. Use Windows
   b. Use computer network system
2. Use File Management Systems
   a. Discuss file management concepts
   b. Create/remove directories
   c. Copy files from floppy disks to hard drive

J. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology

2. Interpret and Understand Basic Layout/types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources
   1. allocates time to complete assigned tasks on schedule
   2. determines cost associated with meeting objectives
   3. determines and allocates required materials and resources for meeting objectives
   4. evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others
   1. participates as a member of the team, contributing to group effort
   2. provides individual assistance/direction to peers as requested
   3. determines and meets internal and external customers' expectations
   4. exercises leadership qualities to effectively communicate ideas and make decisions
   5. negotiates resources in order to accomplish objectives
   6. works well with all members of the class

C. Information: Acquires and uses information
   1. acquires and evaluates information
   2. organizes and maintains information
   3. interprets and communicates information

D. Systems: Understands complex inter-relationships

1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks.

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. demonstrates ability to understand and perform multi-step computations
d. demonstrates ability to read, interpret, and use standard measuring devices
e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations.
   b. demonstrates ability to choose and organize appropriate words to effectively communicate
   c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. *Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long-term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. demonstrates ability to identify potential pitfalls and take evasive actions
   e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. demonstrates maturity to take responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternatives or options for problem solution
   d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. demonstrates ability to initiate and effect solution
   f. demonstrates ability to take responsibility for outcomes
   g. demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery
   d. demonstrates ability to visualize abstractly
   e. demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process

d. demonstrates knowledge of good study skills and learning habits

5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinist Handbook
2. Machinery's Handbook, Industrial Press
3. Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
4. Technology of Machine Tools, Krar, Oswald, St. Amand, McGraw-Hill., 4th Ed.
5. Student's Shop Reference Handbook, Edward Hoffman, Industrial Press

MST 2713
01/081496

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

PRINCIPLES OF CAD

MAST PROGRAM
COURSE SYLLABUS
PRINCIPLES OF CAD

Lecture hours/week: 2 **Lab hours/week: 2** **Credit hours: 3**

COURSE DESCRIPTION:

This course will use CAD machines to design and draw various problems in the architectural, mechanical, and civil drafting areas. Emphasis will be placed on the operations of the CAD system to solve these problems.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: **None**
Lab Manual: **Supplied by Instructor**

Hand Tools/Quantity Required:

3 ½" Floppy Disk	1
3-Ring Binder	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all lab rules and safety regulations

LECTURE OUTLINE:

Lecture Topic	Text Reference Page	Contact Hrs.
Computers in Drafting and Design		
CAD Hardware and Software		

CAD Commands - Getting Started
Lines, Circles and Arcs
Trimming and Editing
Special Geometric Shapes
Moving, Copying, and Rotating
Viewpoint and Layer Control
Configuration Settings
Dimensioning
Sectioning
Peripheral Devices

Total Lecture Hours **32**

LAB OUTLINE:

Lab Topics	Contact Hrs,
Introduction to CAD System and Safety	1
Getting Started with CAD System	2
Creation of Lines, Arc, and Circles	2
Editing Geometry	2
Moving, Copying, and Rotating	2
Viewpoint and Layer Control	2
Project (Drawing-No Dimensions)	3
Project (Drawing-No Dimensions)	3
Dimensioning	2
Project	3
Sectioning	2
Project	3
Peripheral Devices	2
Project	3
Total Lab Hours	**32**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio / percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions

a. Solve for unknown sides / angles of right triangles using trigonometric functions
b. Solve for unknown side of right triangle using Pythagorean's Theorem

4. Use Basic Geometric Principles
   a. Solve for surface area, perimeter, and volume of cube
   b. Solve for surface area, perimeter, and volume of rectangular solid
   c. Solve for surface area, perimeter, and volume of right triangular solid
   d. Solve for surface area, perimeter, and volume of cylinder
   e. Find diagonal of a square

B. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
   a. Read, write, interpret, and apply memorandums
   b. Read, write, interpret, and apply business letters
   c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
   a. Read, write, interpret, and apply technical reports
   b. Read, write, interpret, and apply written procedures
   c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
   a. Demonstrate ability to listen to and understand verbal technical information / instructions
   b. Ask appropriate questions to ascertain needed information
   c. Demonstrate ability to give verbal technical information / instructions
4. Use Graphics for Visual Aid
   a. Create, read, and apply graphs
   b. Create, read, and apply charts
   c. Create, read, and apply graphical illustrations

C. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
   a. Demonstrate isometric sketching of objects
   b. List and apply the three primary planes of projection
   c. List and apply the six principle views.
   d. Use and apply auxiliary views
   e. Create sectional views
2. Use Computer-Aided Drafting (CAD) System
   a. Create geometry using CAD system
   b. Create 3-D solid models
   c. Interconvert CAD and accepted drawing exchange formats
   d. Configure CAD system parameters
   e. Use peripheral devices
3. Use and Apply Geometric Dimensioning and Tolerancing (GD&T) Methodology
   a. Distinguish between conventional and geometric dimensioning and tolerancing.
   b. Explain and use geometric positional tolerancing
   c. Explain and use tolerances of form
   d. Explain and use the feature control symbol
   e. Explain and use modifiers in geometric dimensioning and tolerancing

D. USE COMPUTERS

1. Use Computer Operating Systems

a. Use Windows
b. Use computer network system

2. Use File Management Systems
   a. Discuss file management concepts
   b. Create/remove directories
   c. Copy files from floppy disks to hard drive

E. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology
2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources
   1. allocates time to complete assigned tasks on schedule
   2. determines and allocates required materials and resources for meeting objectives
   3. evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others

1. participates as a member of the team, contributing to group effort
2. provides individual assistance/direction to peers as requested
3. determines and meets internal and external customers' expectations
4. exercises leadership qualities to effectively communicate ideas and make decisions
5. negotiates resources in order to accomplish objectives
6. works well with all members of the class

C. ***Information:*** *Acquires and uses information*
1. acquires and evaluates information
2. organizes and maintains information
3. interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*
1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*
1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. demonstrates ability to understand and perform multi-step computations
d. demonstrates ability to read, interpret, and use standard measuring devices
e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. demonstrates ability to hear, comprehend, and appropriately follow directions
c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
a. demonstrates appropriate listening and speaking skills in personal conversations
b. demonstrates ability to choose and organize appropriate words to effectively communicate
c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.

1. ***Decision Making:*** Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long-term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. demonstrates ability to identify potential pitfalls and take evasive actions
   e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. demonstrates maturity to take responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternatives or options for problem solution
   d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. demonstrates ability to initiate and effect solution
   f. demonstrates ability to take responsibility for outcomes
   g. demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery

d. demonstrates ability to visualize abstractly
e. demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. demonstrates appropriate and acceptable social behaviors in classroom interactions
b. demonstrates ability to work cooperatively in individual, team, or group situations
c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

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*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

DIE DESIGN II

Prerequisite: DIE DESIGN I

MAST PROGRAM
COURSE SYLLABUS
DIE DESIGN II

Lecture hours/week: 2 **Lab hours/week: 2** **Credit hours: 3**

COURSE DESCRIPTION:

This course is a continuation of Die Design I with more emphasis on actual die design and construction. Instruction is given on the considerations involved in developing die components, such as calculation of clearances, cutting force, and press tonnage requirements.

PREREQUISITES: **Die Design I**

REQUIRED COURSE MATERIALS:

Textbook: Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Die and Fixture Design	------	

Safety in a Die Shop	Handout	
Die Engineering - Planning and Design	1-5, 192,193, HO	
Shear Action in Metal Cutting	3, HO	
Principles of Blanking/Piercing Dies	1-22, HO	
Punch Design and Construction	63-86	
Die Block Construction	97-108	
Bending of Metals	23-50, HO	
Bending and Forming Die Design and Construction	27-50, HO	
Strippers and Stock Guides	11,12, 109-127	
Shedders and Knockouts	128-136	
Nest Gages, Pushers, and Die Stops	137-147	
Compound and Combination Dies	Handout	
Progressive Dies	Handout	
Stock Material Utilization and Strip Layouts	172-190	
Other Types of Industrial Dies	Handout	
	Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction to the Design of Dies	1
Safety in the Die Shop	1
Stampings and Their Dies (Visual Survey)	1
Visualization of Die Construction	2
Project (Make Drawing of Existing Die)	5
Project (Design Punch, Punch Plate, and Die Block)	4
Project (Design V-Bend Die)	6
Project (Design Combination Die)	12
Total Lab Hours	**32**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/ Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives
   c. Wear safety/protective equipment as required
2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition
   b. Maintain all guards, shields, and barriers in place and in good condition
   c. Perform preventive maintenance as required
   d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment

a. Keep work areas clean and free of debris
b. Keep isles/traffic areas clear of equipment and materials
c. Store materials, tools, and instruments in organized manner
d. Clean machine/hand tools when work is complete

4. Use Safe Operating Procedures for Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques

a. Discuss factors that affect accurate measurement
b. Determine proper procedure to acquire accurate measurement
c. Determine proper instrument to use in measurement

2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gages
   k. Use Rockwell hardness tester
   l. Use surface plates
3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Identify Materials with Desired Properties
   a. Determine/identify service requirements (strength, hardness, etc.)
   b. Determine, interpret, and evaluate availability of materials
   c. Describe general characteristics of various metals
   d. Know concepts of and calculate statics and stresses
2. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness
   b. Define toughness
   c. Define tensile strength
   d. Define shear strength

e. Define elasticity
f. Define ductility
g. Discuss the Rockwell and Brinell hardness scales
h. Discuss the Charpy/Izod impact tests

3. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Discuss cold forming/workability of various materials
   c. Define work hardening/edge hardening
   d. Identify welding properties of various materials
   e. Demonstrate knowledge of heat treating procedures and properties
   f. Know stress relieving procedures
   g. Know/Find hardness characteristics and chemistry of various materials
4. Discuss Classification System for Metals
   a. Identify and discuss types of carbon steel
   b. Determine chemistry of material by classification
   c. Distinguish between SAE and AISI classification systems
   d. Identify designation of each digit of steel classification
   e. Discuss alloy steels

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Calculate speeds and feeds based on materials and tooling
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Calculate speeds and feeds based on materials and tooling
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines
   f. Discuss drilling safety
   g. Calculate speeds and feeds based on materials and tooling
4. Know Operation of Surface and Cylindrical Grinders
   a. Define grinders, surface and cylindrical

b. Explain types and maintenance of grinding wheels
c. Set-up and operate grinding machines
d. Explain machine components and accessories of grinding machines
e. Explain grinding processes
f. Discuss grinding safety

5. Know Operation of Heat Treating Equipment and Processes
   a. Describe types of heat treating equipment
   b. Set-up and operate heat treating equipment
   c. Explain machine components and accessories of heat treating equipment
   d. Explain heat treating procedures
   e. Discuss heat treating safety
6. Know Operation of Welding Equipment and Processes
   a. Identify various types of welding equipment
   b. Identify and discuss the difference in welding processes
   c. Inspect welds for cracks and penetration
   d. Discuss welding safety
7. Know Sheet Metal Operations
   a. Discuss gas/plasma cutting equipment and processes
   b. Discuss operation of punch/brake presses and tooling
   c. Discuss operation of plate shears
   d. Calculate tonnages required for press/shear operations
   e. Calculate blank dimensions of developed parts
   f. Use yield tables for bending sheet metal
   g. Discuss fabrication of sheet metal parts
   h. Demonstrate layout-on-metal
   i. Apply conservation-of-material concepts
8. Know Operation of Jig-boring Machines and Tooling
   a. Define jig-boring machine
   b. List, describe, and give function and maintenance of different types of tooling used on jig-boring machines
   c. Set-up and operate jig-boring machine
   d. Explain machine components and accessories of jig-boring machines
   e. Explain jig-boring process
   f. Discuss safety on jig-boring machine
   g. Calculate speeds and feeds based on materials and tooling
9. Know Operation of Tool and Cutter Grinders
   a. Define tool/cutter grinder
   b. Discuss dressing and maintenance of grinding wheels
   c. Explain machine components and accessories of tool/cutter grinder
   d. Discuss tool and cutter grinder safety
10. Know Operation of Metal Saws
   a. Define band saw, horizontal and vertical
   b. Set-up and operate band saw
   c. Define abrasive cut-off saw
   d. Set-up and operate abrasive cut-off saw
   e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades
   f. Weld and maintain band saw blade

g. Discuss band saw safety
h. Calculate speeds and feeds based on materials and tooling
i. Explain machine components and accessories of band saws
j. Calculate proper length of band saw blade

11. Estimate Time Required/Cost to Produce a Part
    a. Determine processes required to produce part
    b. Calculate actual machining and handling time
    c. Calculate material quantity and cost
    d. Calculate labor and overhead cost
12. Know Proper Flow of Parts Through Shop
    a. Discuss proper order of processes
    b. Discuss ergonomic aspects of plant layout
13. Utilize Concepts and Principles of Fixturing
    a. Determine need for fixture/jig
    b. Design appropriate fixture/jig
    c. Identify components used in fixtures/jigs
    d. Disassemble and assemble fixture/jig
    e. Discuss relationship between accuracy of fixture and accuracy/ repeatability of parts
14. Make Calculations for and Use Sine Bar/Sine Plate
    a. Define sine bar/sine plate
    b. Calculate gage block buildup for sine bar/sine plate
    c. Set-up and use sine bar/sine plate
15. Make Calculations for and Use Rotary Table and Dividing Head
    a. Set-up and use rotary table/dividing head for machining operations
    b. Make calculations for number of rotations required
    c. Determine/select appropriate index plate for dividing head

F. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
    a. Read, write, interpret, and apply memorandums
    b. Read, write, interpret, and apply business letters
    c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
    a. Read, write, interpret, and apply technical reports
    b. Read, write, interpret, and apply written procedures
    c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
    a. Demonstrate ability to listen to and understand verbal technical information/instructions
    b. Ask appropriate questions to ascertain needed information
    c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
    a. Create, read, and apply graphs
    b. Create, read, and apply charts
    c. Create, read, and apply graphical illustrations

G. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
    a. Demonstrate use of drafting machine and instruments

b. Demonstrate drafting technique to create basic geometric elements
c. Demonstrate isometric sketching of objects
d. List and apply the three primary planes of projection
e. List and apply the six principle views
f. Use and apply auxiliary views
g. Create/Use sectional views

2. Use Computer-Aided Drafting (Cad) System
   a. Create geometry using CAD system
   b. Create 3-D solid models
   c. Interconvert CAD and accepted drawing exchange formats
   d. Configure CAD system parameters
   e. Use peripheral devices
3. Use and Apply Geometric Dimensioning and Tolerancing (GD&T) Methodology
   a. Distinguish between conventional and geometric dimensioning and tolerancing.
   b. Explain and use geometric positional tolerancing
   c. Explain and use tolerances of form
   d. Explain and use the feature control symbol
   e. Explain and use modifiers in geometric dimensioning and tolerancing

H. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

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   a. Distinguish between general and specific notes
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   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology
2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

I. PERFORM DIE OPERATIONS

1. Utilize Basic Die Theory
   a. Discuss shearing action on metal (3 stages)
   b. Define/calculate cutting clearance
   c. Define/calculate proper shut-height of die set
   d. Define/calculate offset displacement
   e. Define/calculate stripping pressure
   f. Define/calculate cutting length of piece part

g. Define/calculate die progression
h. Design stock strip layout
i. Determine die feed direction
j. Explain notch, pierce, pilot, form, and cut-off stations
k. Determine stop block length
l. Determine press tonnage requirements
m. Define/calculate slug clearance
n. Explain operation of die set to make piece part
o. Explain spring back in form dies
p. Explain bending action in V-form dies
q. Explain coining in dies
r. Identify components of die set
s. Discuss materials of die components

2. Perform Die Repair
   a. Disassemble and assemble die set
   b. Visually inspect die components for damage
   c. Identify component parts to be repaired/sharpened
   d. Determine method of repairing/sharpening
   e. Determine material for replacement parts
   f. Manufacture replacement parts
   g. Demonstrate setting correct punch entry
3. Demonstrate Die Making Skills
   a. Identify component parts from die blueprint
   b. Determine material/purchased parts requirements
   c. Utilize die making procedures to make component parts
   d. Utilize die making procedures to mount component parts
   e. Demonstrate mounting of die set in press machine
   f. Cycle die set in press machine and inspect operation
   g. Inspect piece part for accuracy
4. Identify Types of Industrial Dies
   a. Explain blanking or piercing dies
   b. Explain bending or forming dies
   c. Explain draw dies
   d. Explain compression dies
   e. Explain progressive dies
   f. Explain compound dies
   g. Explain combination dies

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*

1. allocates time to complete assigned tasks on schedule
2. determines cost associated with meeting objectives
3. determines and allocates required materials and resources for meeting objectives
4. evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*

1. participates as a member of the team, contributing to group effort
2. provides individual assistance/direction to peers as requested
3. eetermines and meets internal and external customers' expectations
4. exercises leadership qualities to effectively communicate ideas and make decisions
5. negotiates resources in order to accomplish objectives
6. works well with all members of the class

C. ***Information:*** *Acquires and uses information*

1. acquires and evaluates information
2. organizes and maintains information
3. interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*

1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*

1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. demonstrates ability to understand and perform multi-step computations
d. demonstrates ability to read, interpret, and use standard measuring devices
e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. demonstrates ability to hear, comprehend, and appropriately follow directions
c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations
   b. demonstrates ability to choose and organize appropriate words to effectively communicate
   c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long-term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. demonstrates ability to identify potential pitfalls and take evasive actions
   e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. demonstrates maturity to take responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternatives or options for problem solution

d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. demonstrates ability to initiate and effect solution
f. demonstrates ability to take responsibility for outcomes
g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery
   d. demonstrates ability to visualize abstractly
   e. demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion

d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. demonstrates maturity to take responsibility for actions
f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Die Design Fundamentals, J. R. Pacquin and R.E. Crowley, 2nd Ed.

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*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

DIE MAKING II

Prerequisite: DIE MAKING I

MAST PROGRAM
COURSE SYLLABUS
DIE MAKING II

Lecture hours/week: 3 **Lab hours/week: 6** **Credit hours: 6**

COURSE DESCRIPTION:

This course is a continuation of Die Making I with instruction and practice in building a progressive die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I toward fabricating more complex dies.

PREREQUISITES: **Die Making I**

REQUIRED COURSE MATERIALS:

Textbook: Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction and Safety	------	
The Progressive Die	Handout	

The Die Blueprint	Handout	
Component Requirements	Handout	
Material Requirements and Specifications	Handout	
Calculations Required	6-22, HO	
Planning Events	------	
	Total Lecture Hours	**48**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Orientation and Safety	2
Material Inventory	2
Material Requisitioning for Die	2
Project (Progressive Blank/Pierce Die)	84
Tryout of Die	6
Total Lab Hours	**96**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/ Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives
   c. Wear safety/protective equipment as required
2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition
   b. Maintain all guards, shields, and barriers in place and in good condition
   c. Perform preventive maintenance as required
   d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean and free of debris
   b. Keep aisles/traffic areas clear of equipment and materials
   c. Store materials, tools, and instruments in organized manner
   d. Clean machine/hand tools when work is complete
4. Use Safe Operating Procedures for Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds

d. Stay alert and prepared to act during machining
e. Ensure rotating parts/tooling are completely stopped before handling

6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gages
   k. Use Rockwell hardness tester

l. Use surface plates

3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Identify Materials with Desired Properties
   a. Determine/identify service requirements (strength, hardness, etc.)
   b. Determine, interpret, and evaluate availability of materials
   c. Describe general characteristics of various metals
   d. Know concepts of and calculate statics and stresses
2. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness
   b. Define toughness
   c. Define tensile strength
   d. Define shear strength
   e. Define elasticity
   f. Define ductility
   g. Discuss the Rockwell and Brinell hardness scales
   h. Discuss the Charpy/Izod impact tests
3. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Discuss cold forming/workability of various materials
   c. Define work hardening/edge hardening
   d. Identify welding properties of various materials
   e. Demonstrate knowledge of heat treating procedures and properties
   f. Know stress relieving procedures
   g. Know/Find hardness characteristics and chemistry of various materials
4. Discuss Classification System for Metals
   a. Identify and discuss types of carbon steel
   b. Determine chemistry of material by classification

c. Distinguish between SAE and AISI classification systems
d. Identify designation of each digit of steel classification
e. Discuss alloy steels

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Calculate speeds and feeds based on materials and tooling
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Calculate speeds and feeds based on materials and tooling
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines
   f. Discuss drilling safety
   g. Calculate speeds and feeds based on materials and tooling
4. Know Operation of Surface and Cylindrical Grinders
   a. Define grinders, surface and cylindrical
   b. Explain types and maintenance of grinding wheels
   c. Set-up and operate grinding machines
   d. Explain machine components and accessories of grinding machines
   e. Explain grinding processes
   f. Discuss grinding safety
5. Know Operation of Heat Treating Equipment and Processes
   a. Describe types of heat treating equipment
   b. Set-up and operate heat treating equipment
   c. Explain machine components and accessories of heat treating equipment
   d. Explain heat treating procedures
   e. Discuss heat treating safety
6. Know Operation of Welding Equipment and Processes
   a. Identify various types of welding equipment
   b. Identify and discuss the difference in welding processes
   c. Inspect welds for cracks and penetration

d. Discuss welding safety

7. Know Sheet Metal Operations
   a. Discuss gas/plasma cutting equipment and processes
   b. Discuss operation of punch/brake presses and tooling
   c. Discuss operation of plate shears
   d. Calculate tonnages required for press/shear operations
   e. Calculate blank dimensions of developed parts
   f. Use yield tables for bending sheet metal
   g. Discuss fabrication of sheet metal parts
   h. Demonstrate layout-on-metal
   i. Apply conservation-of-material concepts
8. Know Operation of Jig-boring Machines and Tooling
   a. Define jig-boring machine
   b. List, describe, and give function and maintenance of different types of tooling used on jig-boring machines
   c. Set-up and operate jig-boring machine
   d. Explain machine components and accessories of jig-boring machines
   e. Explain jig-boring process
   f. Discuss safety on jig-boring machine
   g. Calculate speeds and feeds based on materials and tooling
9. Know Operation of Tool and Cutter Grinders
   a. Define tool/cutter grinder
   b. Discuss dressing and maintenance of grinding wheels
   c. Explain machine components and accessories of tool/cutter grinder
   d. Discuss tool and cutter grinder safety
10. Know Operation of Metal Saws
   a. Define band saw, horizontal and vertical
   b. Set-up and operate band saw
   c. Define abrasive cut-off saw
   d. Set-up and operate abrasive cut-off saw
   e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades
   f. Weld and maintain band saw blade
   g. Discuss band saw safety
   h. Calculate speeds and feeds based on materials and tooling
   i. Explain machine components and accessories of band saws
   j. Calculate proper length of band saw blade
11. Know Operation of Wire EDM
   a. Define EDM
   b. Explain EDM process
   c. Set-up and operate CNC wire EDM
   d. Discuss EDM safety
   e. Calculate E-pac value for wire EDM
   f. Explain machine components and accessories of wire EDM
12. Estimate Time Required/Cost to Produce a Part
   a. Determine processes required to produce part
   b. Calculate actual machining and handling time
   c. Calculate material quantity and cost

d. Calculate labor and overhead cost

13. Know Proper Flow of Parts Through Shop
    a. Discuss proper order of processes
    b. Discuss ergonomic aspects of plant layout
14. Utilize Concepts and Principles of Fixturing
    a. Determine need for fixture/jig
    b. Design appropriate fixture/jig
    c. Identify components used in fixtures/jigs
    d. Disassemble and assemble fixture/jig
    e. Discuss relationship between accuracy of fixture and accuracy/ repeatability of parts
15. Make Calculations for and Use Sine Bar/Sine Plate
    a. Define sine bar/sine plate
    b. Calculate gage block buildup for sine bar/sine plate
    c. Set-up and use sine bar/sine plate
16. Make Calculations for and Use Rotary Table and Dividing Head
    a. Set-up and use rotary table/dividing head for machining operations
    b. Make calculations for number of rotations required
    c. Determine/select appropriate index plate for dividing head

F. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
    a. Read, write, interpret, and apply memorandums
    b. Read, write, interpret, and apply business letters
    c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
    a. Read, write, interpret, and apply technical reports
    b. Read, write, interpret, and apply written procedures
    c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
    a. Demonstrate ability to listen to and understand verbal technical information/instructions
    b. Ask appropriate questions to ascertain needed information
    c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
    a. Create, read, and apply graphs
    b. Create, read, and apply charts
    c. Create, read, and apply graphical illustrations

G. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
    a. List and apply the three primary planes of projection
    b. List and apply the six principle views
    c. Use and apply auxiliary views
    d. Create/use sectional views

H. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
    a. Distinguish between general and specific notes
    b. Interpret and apply general and specific notes
    c. Determine and apply dimensions on a drawing

d. Identify basic symbols found on a drawing
e. Identify tolerances on a drawing
f. Discuss GD&T methodology

2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

I. PERFORM DIE OPERATIONS

1. Utilize Basic Die Theory and Principles of Die Design
   a. Discuss shearing action on metal (3 stages)
   b. Define/calculate cutting clearance
   c. Define/calculate proper shut-height of die set
   d. Define/calculate offset displacement
   e. Define/calculate stripping pressure
   f. Define/calculate cutting length of piece part
   g. Define/calculate die progression
   h. Design stock strip layout
   i. Determine die feed direction
   j. Explain notch, pierce, pilot, form, and cut-off stations
   k. Determine stop block length
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   n. Explain operation of die set to make piece part
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   b. Visually inspect die components for damage
   c. Identify component parts to be repaired/sharpened
   d. Determine method of repairing/sharpening
   e. Determine material for replacement parts
   f. Manufacture replacement parts
   g. Demonstrate setting correct punch entry
3. Demonstrate Die Making Skills
   a. Identify component parts from die blueprint
   b. Determine material/purchased parts requirements

c. Utilize die making procedures to make component parts
d. Utilize die making procedures to mount component parts
e. Demonstrate mounting of die set in press machine
f. Cycle die set in press machine and inspect operation
g. Inspect piece part for accuracy

COURSE OBJECTIVES: SCANS COMPETENCIES

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The following activities will be performed by each student for successful completion of this course:

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1. allocates time to complete assigned tasks on schedule
2. determines cost associated with meeting objectives
3. determines and allocates required materials and resources for meeting objectives
4. evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*
1. participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. determines and meets internal and external customers' expectations
4. exercises leadership qualities to effectively communicate ideas and make decisions
5. negotiates resources in order to accomplish objectives
6. works well with all members of the class

C. ***Information:*** *Acquires and uses information*
1. acquires and evaluates information
2. organizes and maintains information
3. interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*
1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*
1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

*A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

*3. **Arithmetic/Mathematics:** Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents.

b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. demonstrates ability to understand and perform multi-step computations

d. demonstrates ability to read, interpret, and use standard measuring devices

e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations
   b. demonstrates ability to choose and organize appropriate words to effectively communicate
   c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long-term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. demonstrates ability to identify potential pitfalls and take evasive actions

e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. demonstrates maturity to take responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternatives or options for problem solution
   d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. demonstrates ability to initiate and effect solution
   f. demonstrates ability to take responsibility for outcomes
   g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery
   d. demonstrates ability to visualize abstractly
   e. demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice

e. recognizes that attitudes, skills, and practice are essential to productivity
f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules

d. demonstrates ability to wisely use classroom time
e. demonstrates use of good study habits and skills
f. demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Die Design Fundamentals, J. R. Pacquin and R.E. Crowley, 2nd Ed.

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03/081496

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

COMPUTER NUMERICAL CONTROL OPERATIONS II

Prerequisite: COMPUTER NUMERICAL CONTROL OPERATIONS I

MAST PROGRAM
COURSE SYLLABUS
COMPUTER NUMERICAL CONTROL OPERATIONS II

Lecture hours/week: 2 **Lab hours/week: 2** **Credit hours: 3**

COURSE DESCRIPTION:

This course is a continuation of CNC Operations I with additional instruction in writing and editing CNC code manually, utilizing more advanced commands and cycles. Additionally, students will be introduced to the use of a Computer-Aided Manufacturing (CAM) system for creation of code.

PREREQUISITES: Computer Numerical Control Operations I

REQUIRED COURSE MATERIALS:

Textbook: An Introduction to CNC Machining and Programming, David Gibbs and Thomas M. Crandell, Industrial Press

Lab Manual: Instructor Provided Materials

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Safety with CNC Equipment	------	
Introduction to CNC Lathe (Industrial Lathe)	Handout	
Tooling Systems for CNC Lathes	41-77, HO	
Advanced Programming Cycles (CANNED)	137-146, HO	
Introduction to CNC Mill (Industrial Mill)	Handout	
Tooling Systems for CNC Mills	41-77, Handout	
Advanced Programming Cycles (CANNED)	137-146, HO	
Jigs and Fixtures for CNC Equipment	78-94, HO	
Programming for Production and Efficiency	436-459, HO	
Introduction to Computer-Aided Manufacturing (CAM)	334-435, HO	
	Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
CNC Machines and Safety	1
Operation of CNC Industrial Lathe	2
Tooling Systems	1
Project (Turn and Journal Shaft)	2
Project (Turn Part with Radii, Angles, and Grooves)	3
Project (Threaded Shaft with Tapped End Hole)	3
Operation of CNC Industrial Mill	2
Tooling Systems	1
Project (Drilled and Milled Plate)	2
Project (Milled Plate with Pocket and Name)	3
Project (Production Part for Lathe)	4
Project (Production Part for Mill)	4
Field Trip (CNC Machine Shop)	4
Total Lab Hours	**32**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/ Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives

c. Wear safety/protective equipment as required

2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition
   b. Maintain all guards, shields, and barriers in place and in good condition
   c. Perform preventive maintenance as required
   d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean and free of debris
   b. Keep isles/traffic areas clear of equipment and materials
   c. Store materials, tools, and instruments in organized manner
   d. Clean machine/hand tools when work is complete
4. Use Safe Operating Procedures for Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric

functions
b. Solve for unknown side of right triangle using Pythagorean's Theorem

4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Calculate coordinates of bolt circle on Cartesian coordinate system
   c. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gages
   k. Use Rockwell hardness tester
   l. Use surface plates
3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness

b. Define toughness

2. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Define work hardening/edge hardening

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Discuss CNC machining centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC machining center
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Discuss CNC turning centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC turning center
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines
   f. Discuss drilling safety
   g. Discuss drilling operations on CNC drilling machines
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC drilling machine
4. Estimate Time Required/Cost to Produce a Part
   a. Determine processes required to produce part
   b. Calculate actual machining and handling time
   c. Calculate material quantity and cost
   d. Calculate labor and overhead cost
5. Know Proper Flow of Parts Through Shop
   a. Discuss proper order of processes
   b. Discuss ergonomic aspects of plant layout
6. Utilize Concepts and Principles of Fixturing
   a. Determine need for fixture/jig

b. Design appropriate fixture/jig
c. Identify components used in fixtures/jigs
d. Disassemble and assemble fixture/jig
e. Discuss relationship between accuracy of fixture and accuracy/ repeatability of parts

F. PERFORM CNC PROGRAMMING/CAM TASKS

1. Prepare and Plan for CNC Machining Operations
   a. Plan sequence of machining events
   b. Determine proper tooling/fixtures required for machining
   c. Calculate speeds, feeds, and depth-of-cut for machining
   d. Explain the x, y, and z axis on CNC machines
2. Select and Use Tooling Systems for CNC Machines
   a. Understand machinability and chip formation
   b. Select proper insert materials and geometry
   c. Select proper tooling system
   d. Define and discuss application of HSS, carbide, and borazon cutting tools
3. Manually Program CNC Machines
   a. Plan and write programs for CNC machines
   b. Use MDI panel on machine to program/edit programs
   c. Set and use tooling offsets at CNC machine
   d. Discuss/use canned or bar cycles in program
4. Use Computer-Aided Manufacturing (CAM) System
   a. Create toolpath geometry using CAM system
   b. Transfer files from CAM system to machine

G. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
   a. Read, write, interpret, and apply memorandums
   b. Read, write, interpret, and apply business letters
   c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
   a. Read, write, interpret, and apply technical reports
   b. Read, write, interpret, and apply written procedures
   c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
   a. Demonstrate ability to listen to and understand verbal technical information/instructions
   b. Ask appropriate questions to ascertain needed information
   c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
   a. Create, read, and apply graphs
   b. Create, read, and apply charts
   c. Create, read, and apply graphical illustrations

H. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
   a. List and apply the three primary planes of projection
   b. List and apply the six principle views
   c. Use and apply auxiliary views
   d. Create/use sectional views

I. **USE COMPUTERS**
   1. Use Computer Operating Systems
      a. Use Windows
      b. Use computer network system
   2. Use File Management Systems
      a. Discuss file management concepts
      b. Create/remove directories
      c. Copy files from floppy disks to hard drive

J. **INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS**
   1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
      a. Distinguish between general and specific notes
      b. Interpret and apply general and specific notes
      c. Determine and apply dimensions on a drawing
      d. Identify basic symbols found on a drawing
      e. Identify tolerances on a drawing
      f. Discuss GD&T methodology
   2. Interpret and Understand Basic Layout/Types of Drawings
      a. Identify types of drawings
      b. Identify parts of a drawing and list components of each
      c. Identify types of lines on a drawing
      d. List and describe the different views found on a drawing
   3. Understand and Analyze Bill-of-Materials
      a. Determine materials required
      b. Determine quantities required
      c. Identify item symbol and/or part number
   4. Ascertain Job Requirements from Drawings
      a. Interpret part requirements
      b. Identify surfaces to be machined
      c. Determine critical dimensions

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. allocates time to complete assigned tasks on schedule
      2. determines cost associated with meeting objectives

3. determines and allocates required materials and resources for meeting objectives
4. evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*

1. participates as a member of the team, contributing to group effort
2. provides individual assistance/direction to peers as requested
3. determines and meets internal and external customers' expectations
4. exercises leadership qualities to effectively communicate ideas and make decisions.
5. negotiates resources in order to accomplish objectives
6. works well with all members of the class

C. ***Information:*** *Acquires and uses information*

1. aquires and evaluates information
2. organizes and maintains information
3. interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*

1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*

1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. ***Basic Skills:*** Reads, writes, performs arithmetic and mathematical operations, listens and speaks.

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. **Arithmetic/Mathematics:** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
   b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. demonstrates ability to understand and perform multi-step computations
   d. demonstrates ability to read, interpret, and use standard measuring devices
   e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. *Speaking: Organizes ideas and communicates orally*

a. demonstrates appropriate listening and speaking skills in personal conversations
b. demonstrates ability to choose and organize appropriate words to effectively communicate
c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. demonstrates ability to objectively assess personal strengths and weaknesses
b. demonstrates ability to set realistic short-term and long-term goals
c. demonstrates ability to recognize and distinguish between positive and negative alternatives
d. demonstrates ability to identify potential pitfalls and take evasive actions
e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. demonstrates maturity to take responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. demonstrates ability to detect problem through observation, inquiry, or directive
b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. demonstrates ability to generate alternatives or options for problem solution
d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. demonstrates ability to initiate and effect solution
f. demonstrates ability to take responsibility for outcomes
g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. demonstrates ability to visually discriminate in gross and fine imagery
d. demonstrates ability to visualize abstractly
e. demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors

c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. demonstrates ability to accept and use constructive criticism
f. accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinist Handbook
2. Machinery's Handbook, Industrial Press
3. Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
4. Technology of Machine Tools, Krar, Oswald, St. Amand, McGraw-Hill., 4th Ed.
5. Student's Shop Reference Handbook, Edward Hoffman, Industrial Press
6. Jig and Fixture Handbook, Carr Lane Manufacturing Co.

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

DIE MAKING III

Prerequisite: DIE MAKING II

MAST PROGRAM
COURSE SYLLABUS
DIE MAKING III

Lecture hours/week: 2 **Lab hours/week: 4** **Credit hours: 4**

COURSE DESCRIPTION:

This course is a continuation of Die Making II with instruction and practice in building a compound die from a blueprint. Emphasis is placed on the application of the die building procedures learned in Die Making I and Die Making II toward fabricating more complex dies. Instruction and practice is also given on the use of the Wire Electrical Discharge Machine in the construction of die components.

PREREQUISITES: **Die Making II**

REQUIRED COURSE MATERIALS:

Textbook: Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction and Safety	------	
The Compound Die	Handout	
The Die Blueprint	Handout	
Capabilities of the Wire EDM in Die Building	------	
Assistance Planning Material Requirements and Events	------	
Assistance with Required Calculations	6-22, HO	
Operation of the Wire EDM	Handout	
	Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics		Contact Hrs.
Orientation and Safety		2
Material Inventory		2
Material Requisitioning for Die		2
Project (Compound Die)		50
Operation of the Wire EDM		4
Tryout of Die		4
	Total Lab Hours	**64**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/ Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives
   c. Wear safety/protective equipment as required
2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition
   b. Maintain all guards, shields, and barriers in place and in good condition
   c. Perform preventive maintenance as required
   d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean and free of debris
   b. Keep isles/traffic areas clear of equipment and materials
   c. Store materials, tools, and instruments in organized manner
   d. Clean machine/hand tools when work is complete
4. Use Safe Operating Procedures for Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment

c. Operate hand and machine tools in safe manner
d. Comply with manufacturer's rated capacity for equipment
e. Ensure all rotating or moving parts have stopped before leaving area
f. Inspect for and remove possible hazards before engaging equipment

5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance

c. Read and use O.D., I.D., and depth micrometers
d. Read and use vernier, dial, & digital calipers
e. Read and use scale and tape measure
f. Read and use dial-bore indicators
g. Use dial indicators
h. Use precision square and combination set
i. Read and use digital read-out
j. Use finish/profile gages
k. Use Rockwell hardness tester
l. Use surface plates

3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Identify Materials with Desired Properties
   a. Determine/identify service requirements (strength, hardness, etc.)
   b. Determine, interpret, and evaluate availability of materials
   c. Describe general characteristics of various metals
   d. Know concepts of and calculate statics and stresses
2. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness
   b. Define toughness
   c. Define tensile strength
   d. Define shear strength
   e. Define elasticity
   f. Define ductility
   g. Discuss the Rockwell and Brinell hardness scales
   h. Discuss the Charpy/Izod impact tests
3. Identify Manufacturing Properties of Materials

a. Discuss machinability of various materials
b. Discuss cold forming/workability of various materials
c. Define work hardening/edge hardening
d. Identify welding properties of various materials
e. Demonstrate knowledge of heat treating procedures and properties
f. Know stress relieving procedures
g. Know/Find hardness characteristics and chemistry of various materials

4. Discuss Classification System for Metals
   a. Identify and discuss types of carbon steel
   b. Determine chemistry of material by classification
   c. Distinguish between SAE and AISI classification systems
   d. Identify designation of each digit of steel classification
   e. Discuss alloy steels

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Calculate speeds and feeds based on materials and tooling
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Calculate speeds and feeds based on materials and tooling
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines
   f. Discuss drilling safety
   g. Calculate speeds and feeds based on materials and tooling
4. Know Operation of Surface and Cylindrical Grinders
   a. Define grinders, surface and cylindrical
   b. Explain types and maintenance of grinding wheels
   c. Set-up and operate grinding machines
   d. Explain machine components and accessories of grinding machines
   e. Explain grinding processes

f. Discuss grinding safety

5. Know Operation of Heat Treating Equipment and Processes
   a. Describe types of heat treating equipment
   b. Set-up and operate heat treating equipment
   c. Explain machine components and accessories of heat treating equipment
   d. Explain heat treating procedures
   e. Discuss heat treating safety.
6. Know Operation of Welding Equipment and Processes
   a. Identify various types of welding equipment
   b. Identify and discuss the difference in welding processes
   c. Inspect welds for cracks and penetration
   d. Discuss welding safety
7. Know Sheet Metal Operations
   a. Discuss gas/plasma cutting equipment and processes
   b. Discuss operation of punch/brake presses and tooling
   c. Discuss operation of plate shears
   d. Calculate tonnages required for press/shear operations
   e. Calculate blank dimensions of developed parts
   f. Use yield tables for bending sheet metal
   g. Discuss fabrication of sheet metal parts
   h. Demonstrate layout-on-metal
   i. Apply conservation-of-material concepts
8. Know Operation of Jig-boring Machines and Tooling
   a. Define jig-boring machine
   b. List, describe, and give function and maintenance of different types of tooling used on jig-boring machines
   c. Set-up and operate jig-boring machine
   d. Explain machine components and accessories of jig-boring machines
   e. Explain jig-boring process
   f. Discuss safety on jig-boring machine
   g. Calculate speeds and feeds based on materials and tooling
9. Know Operation of Tool and Cutter Grinders
   a. Define tool/cutter grinder
   b. Discuss dressing and maintenance of grinding wheels
   c. Explain machine components and accessories of tool/cutter grinder
   d. Discuss tool and cutter grinder safety
10. Know Operation of Metal Saws
   a. Define band saw, horizontal and vertical
   b. Set-up and operate band saw
   c. Define abrasive cut-off saw
   d. Set-up and operate abrasive cut-off saw
   e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades
   f. Weld and maintain band saw blade
   g. Discuss band saw safety
   h. Calculate speeds and feeds based on materials and tooling
   i. Explain machine components and accessories of band saws

j. Calculate proper length of band saw blade

11. Know Operation of Wire EDM
    a. Define EDM
    b. Explain EDM process
    c. Set-up and operate CNC wire EDM
    d. Discuss EDM safety
    e. Calculate E-pac value for wire EDM
    f. Explain machine components and accessories of wire EDM
12. Estimate Time Required/Cost to Produce a Part
    a. Determine processes required to produce part
    b. Calculate actual machining and handling time
    c. Calculate material quantity and cost
    d. Calculate labor and overhead cost
13. Know Proper Flow of Parts Through Shop
    a. Discuss proper order of processes
    b. Discuss ergonomic aspects of plant layout
14. Utilize Concepts and Principles of Fixturing
    a. Determine need for fixture/jig
    b. Design appropriate fixture/jig
    c. Identify components used in fixtures/jigs
    d. Disassemble and assemble fixture/jig
    e. Discuss relationship between accuracy of fixture and accuracy/ repeatability of parts
15. Make Calculations for and Use Sine Bar/Sine Plate
    a. Define sine bar/sine plate
    b. Calculate gage block buildup for sine bar/sine plate
    c. Set-up and use sine bar/sine plate
16. Make Calculations for and Use Rotary Table and Dividing Head
    a. Set-up and use rotary table/dividing head for machining operations
    b. Make calculations for number of rotations required
    c. Determine/select appropriate index plate for dividing head

F. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
    a. Read, write, interpret, and apply memorandums
    b. Read, write, interpret, and apply business letters
    c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
    a. Read, write, interpret, and apply technical reports
    b. Read, write, interpret, and apply written procedures
    c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
    a. Demonstrate ability to listen to and understand verbal technical information/instructions
    b. Ask appropriate questions to ascertain needed information
    c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
    a. Create, read, and apply graphs

b. Create, read, and apply charts
c. Create, read, and apply graphical illustrations

G. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
   a. List and apply the three primary planes of projection
   b. List and apply the six principle views
   c. Use and apply auxiliary views
   d. Create/use sectional views

H. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology
2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

I. PERFORM DIE OPERATIONS

1. Utilize Basic Die Theory and Principles of Die Design
   a. Discuss shearing action on metal (3 stages)
   b. Define/calculate cutting clearance
   c. Define/calculate proper shut-height of die set
   d. Define/calculate offset displacement
   e. Define/calculate stripping pressure
   f. Define/calculate cutting length of piece part
   g. Define/calculate die progression
   h. Design stock strip layout
   i. Determine die feed direction
   j. Explain notch, pierce, pilot, form, and cut-off stations
   k. Determine stop block length
   l. Determine press tonnage requirements
   m. Define/calculate slug clearance
   n. Explain operation of die set to make piece part
   o. Explain spring back in form dies
   p. Explain bending action in V-form dies

q. Explain coining in dies
r. Identify components of die set
s. Discuss materials of die components

2. Perform Die Repair
   a. Disassemble and assemble die set
   b. Visually inspect die components for damage
   c. Identify component parts to be repaired/sharpened
   d. Determine method of repairing/sharpening
   e. Determine material for replacement parts
   f. Manufacture replacement parts
   g. Demonstrate setting correct punch entry
3. Demonstrate Die Making Skills
   a. Identify component parts from die blueprint
   b. Determine material/purchased parts requirements
   c. Utilize die making procedures to make component parts
   d. Utilize die making procedures to mount component parts
   e. Demonstrate mounting of die set in press machine
   f. Cycle die set in press machine and inspect operation
   g. Inspect piece part for accuracy
4. Demonstrate Understanding of Different Types of Industrial Dies
   a. Describe the operation and major components of blanking or piercing dies
   b. Describe the operation and major components of bending or forming dies
   c. Describe the operation and major components of draw dies
   d. Describe the operation and major components of compression dies
   e. Describe the operation and major components of progressive dies
   f. Describe the operation and major components of compound dies
   g. Describe the operation and major components of combination dies

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources
   1. allocates time to complete assigned tasks on schedule
   2. determines cost associated with meeting objectives

3. determines and allocates required materials and resources for meeting objectives
4. evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*

1. participates as a member of the team, contributing to group effort
2. provides individual assistance/direction to peers as requested
3. determines and meets internal and external customers' expectations
4. exercises leadership qualities to effectively communicate ideas and make decisions
5. negotiates resources in order to accomplish objectives
6. works well with all members of the class

C. ***Information:*** *Acquires and uses information*

1. acquires and evaluates information
2. organizes and maintains information
3. interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*

1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*

1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
   b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. demonstrates ability to understand and perform multi-step computations
   d. demonstrates ability to read, interpret, and use standard measuring devices
   e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations
   b. demonstrates ability to choose and organize appropriate words to effectively communicate
   c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long-term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. demonstrates ability to identify potential pitfalls and take evasive actions
   e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. demonstrates maturity to take responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternatives or options for problem solution
   d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. demonstrates ability to initiate and effect solution
   f. demonstrates ability to take responsibility for outcomes
   g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery
   d. demonstrates ability to visualize abstractly
   e. demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Die Design Fundamentals, J. R. Pacquin and R.E. Crowley, 2nd Ed.

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

COMPUTER NUMERICAL CONTROL OPERATIONS III

Prerequisite: COMPUTER NUMERICAL CONTROL OPERATIONS II

MAST PROGRAM
COURSE SYLLABUS
COMPUTER NUMERICAL CONTROL OPERATIONS III

Lecture hours/week: 2 **Lab hours/week: 3** **Credit hours: 3**

COURSE DESCRIPTION:

This course is a continuation of CNC Operations I and II with additional instruction and practice in the use of the Computer-Aided Manufacturing (CAM) system for creation of code. Also, the student will be introduced to the Wire Electrical Discharge Machine (EDM) and the Coordinate Measuring Machine (CMM).

PREREQUISITES: **Computer Numerical Control Operations II**

REQUIRED COURSE MATERIALS:

Textbook: An Introduction to CNC Machining and Programming, David Gibbs and Thomas M. Crandell, Industrial Press

Lab Manual: Instructor Provided Materials

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" machining process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Safety with CNC Equipment	------	
Overview of CAM System	334-435, HO	
Creating Geometric Elements and Toolpath	334-351, HO	
Macros and Automated Roughing Commands	Handout	
Postprocessors and Creating Code	Handout	
Importing CAD Data into CAM System	Handout	
Introduction to Electrical Discharge Machining	Handout	
Setup and Operation of the Wire EDM	Handout	
Programming the Wire EDM	Handout	
Operation of the Coordinate Measuring Machine (CMM)	Handout	
Quality Systems and Reverse Engineering	Handout	
	Total Lecture Hours	**32**

LAB OUTLINE:

Lab Topics	Contact Hrs.
CNC Machines and Safety	1
Installing, Configuring and Modules of CAM System	3
Creating Toolpath with CAM System	6
Project (Lathe Part)	3
Project (Mill Part)	3
Project (Create and Import CAD File to Create Code)	2
Operation of Wire EDM	4
Project (Die Block)	4
Project (Pinion Gear)	4
Project (Die Block with Compound Angles)	6
Operation of CMM	6
Project (Measure Die Block and Compile Data)	6
Total Lab Hours	**32**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/ Requirements
   a. Comply with established company and OSHA regulations
   b. Interpret safety manual directives

c. Wear safety/protective equipment as required

2. Maintain Safe Equipment and Machinery
   a. Maintain equipment/tooling in safe operating condition
   b. Maintain all guards, shields, and barriers in place and in good condition
   c. Perform preventive maintenance as required
   d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean and free of debris
   b. Keep aisles/traffic areas clear of equipment and materials
   c. Store materials, tools, and instruments in organized manner
   d. Clean machine/hand tools when work is complete
4. Use Safe Operating Procedures for Hand and Machine Tools
   a. Use tools for intended purposes only
   b. Acquire proper training/authorization before operating equipment
   c. Operate hand and machine tools in safe manner
   d. Comply with manufacturer's rated capacity for equipment
   e. Ensure all rotating or moving parts have stopped before leaving area
   f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   a. Ensure stock/tooling is secure before machining
   b. Use chip control methods
   c. Use moderate, safe, and calculated speeds and feeds
   d. Stay alert and prepared to act during machining
   e. Ensure rotating parts/tooling are completely stopped before handling
6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric

functions
b. Solve for unknown side of right triangle using Pythagorean's Theorem

4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Calculate coordinates of bolt circle on Cartesian coordinate system
   c. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out
   j. Use finish/profile gages
   k. Use Rockwell hardness tester
   l. Use surface plates
3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness

b. Define toughness

2. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Define work hardening/edge hardening

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Discuss CNC machining centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC machining center
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Discuss CNC turning centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC turning center
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines
   f. Discuss drilling safety
   g. Discuss drilling operations on CNC drilling machines
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC drilling machine
4. Know Operation of Wire EDM
   a. Define EDM
   b. Explain EDM process
   c. Set-up and operate CNC wire EDM
   d. Discuss EDM safety
   e. Calculate E-pac value for wire EDM
   f. Explain machine components and accessories of wire EDM
5. Estimate Time Required/Cost to Produce a Part
   a. Determine processes required to produce part
   b. Calculate actual machining and handling time

c. Calculate material quantity and cost
d. Calculate labor and overhead cost

6. Know Proper Flow of Parts Through Shop
   a. Discuss proper order of processes
   b. Discuss ergonomic aspects of plant layout
7. Utilize Concepts and Principles of Fixturing
   a. Determine need for fixture/jig
   b. Design appropriate fixture/jig
   c. Identify components used in fixtures/jigs
   d. Disassemble and assemble fixture/jig
   e. Discuss relationship between accuracy of fixture and accuracy/ repeatability of parts

F. PERFORM CNC PROGRAMMING/CAM TASKS

1. Prepare and Plan for CNC Machining Operations
   a. Plan sequence of machining events
   b. Determine proper tooling/fixtures required for machining
   c. Calculate speeds, feeds, and depth-of-cut for machining
   d. Explain the x, y, and z axis on CNC machines
2. Select and Use Tooling Systems for CNC Machines
   a. Understand machinability and chip formation
   b. Select proper insert materials and geometry
   c. Select proper tooling system
   d. Define and discuss application of HSS, carbide, and borazon cutting tools
3. Manually Program CNC Machines
   a. Plan and write programs for CNC machines
   b. Use MDI panel on machine to program/edit programs
   c. Set and use tooling offsets at CNC machine
   d. Discuss/use canned or bar cycles in program
4. Use Computer-Aided Manufacturing (CAM) System
   a. Create toolpath geometry using CAM system
   b. Interconvert CAD and CAM files using acceptable exchange format
   c. Transfer files from CAM system to machine
   d. Configure CAM system parameters

G. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
   a. Read, write, interpret, and apply memorandums
   b. Read, write, interpret, and apply business letters
   c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
   a. Read, write, interpret, and apply technical reports
   b. Read, write, interpret, and apply written procedures
   c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
   a. Demonstrate ability to listen to and understand verbal technical information/instructions
   b. Ask appropriate questions to ascertain needed information
   c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid

a. Create, read, and apply graphs
b. Create, read, and apply charts
c. Create, read, and apply graphical illustrations

H. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
   a. List and apply the three primary planes of projection
   b. List and apply the six principle views
   c. Use and apply auxiliary views
   d. Create/use sectional views
2. Use Computer-Aided Drafting (CAD) System
   a. Create geometry using CAD system
   b. Create 3-D solid models
   c. Interconvert CAD and accepted drawing exchange formats
   d. Use peripheral devices

I. USE COMPUTERS

1. Use Computer Operating Systems
   a. Explain the phrase "IBM compatible"
   b. Use DOS operating system/DOS commands
   c. Use Windows
   d. Use computer network system
2. Use File Management Systems
   a. Discuss file management concepts
   b. Create/remove directories
   c. Copy files from floppy disks to hard drive
3. Install/Use Software Packages
   a. Install software package to hard disk
   b. Configure system parameters for software package
4. Understand and Apply Computer Terminology
   a. Define Read Only Memory (ROM)
   b. Define Random Access Memory (RAM)
   c. Define byte, kilobyte, megabyte
   d. Define Central Processing Unit (CPU)
   e. Discuss processor speed
   f. Understand RS-232 protocol

J. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology
2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials

a. Determine materials required
b. Determine quantities required
c. Identify item symbol and/or part number

4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources
1. allocates time to complete assigned tasks on schedule
2. determines cost associated with meeting objectives
3. determines and allocates required materials and resources for meeting objectives
4. evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others
1. participates as a member of the team, contributing to group effort
2. provides individual assistance/direction to peers as requested
3. determines and meets internal and external customers' expectations
4. exercises leadership qualities to effectively communicate ideas and make decisions
5. negotiates resources in order to accomplish objectives
6. works well with all members of the class

C. Information: Acquires and uses information
1. acquires and evaluates information
2. organizes and maintains information
3. interprets and communicates information

D. Systems: Understands complex inter-relationships
1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. Technology: Works with a variety of technologies
1. chooses relevant procedures, tools and equipment

2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks.

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques

a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. demonstrates ability to understand and perform multi-step computations

d. demonstrates ability to read, interpret, and use standard measuring devices
e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations
   b. demonstrates ability to choose and organize appropriate words to effectively communicate
   c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. demonstrates ability to objectively assess personal strengths and weaknesses
   b. demonstrates ability to set realistic short-term and long-term goals
   c. demonstrates ability to recognize and distinguish between positive and negative alternatives

d. demonstrates ability to identify potential pitfalls and take evasive actions
e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. demonstrates maturity to take responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. demonstrates ability to detect problem through observation, inquiry, or directive
   b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. demonstrates ability to generate alternatives or options for problem solution
   d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. demonstrates ability to initiate and effect solution
   f. demonstrates ability to take responsibility for outcomes
   g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. demonstrates ability to visually discriminate in gross and fine imagery
   d. demonstrates ability to visualize abstractly
   e. demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships

d. demonstrates and applies knowledge through practice
e. recognizes that attitudes, skills, and practice are essential to productivity
f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. *Personal Qualities:* Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. presents a positive attitude toward tasks
   b. demonstrates ability to separate work and personal behaviors
   c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. demonstrates ability to accept and use constructive criticism
   f. accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner

c. demonstrates ability to formulate and follow personal schedules
d. demonstrates ability to wisely use classroom time
e. demonstrates use of good study habits and skills
f. demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
3. Technology of Machine Tools, Krar, Oswald, St. Amand, McGraw-Hill., 4th Ed.
4. Student's Shop Reference Handbook, Edward Hoffman, Industrial Press

MST 2733
03/01/1496

*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

SPECIAL PROJECT

Prerequisite: DIE MAKING II

MAST PROGRAM
COURSE SYLLABUS
SPECIAL PROJECT

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

This course is designed to provide the student with practical application of skills and knowledge gained through other courses in the Tool and Die Technology Program. Students will apply material learned in previous and concurrent classes to design, produce, and test an industrial quality die. Emphasis is placed on the student making decisions, setting priorities and time lines, and realizing the overall responsibility of producing a quality product in a given amount of time.

PREREQUISITES: **Die Making II**

REQUIRED COURSE MATERIALS:

Textbook: Basic Diemaking, D. Eugene Ostergaard, McGraw-Hill

Hand Tools/Quantity Required:

Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 grad.

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a "hands-on" process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments
2. apply theory to laboratory assignments
3. satisfactorily perform on written, oral, and practical examinations
4. satisfactorily perform on outside assignments including writing assignments
5. contribute to class discussions
6. maintain attendance per current policy
7. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction and Safety	------	
Assignment of Project	Handout	
Instructor Assistance as Needed	------	
	Total Lecture Hours	**16**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Orientation and Safety	1
Project (Design of Progressive Die)	9
Project (Fabrication of Die)	50
Tryout of Die	4
Total Lab Hours	**64**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

After the successful completion of this course the student will be able to:

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/Requirements
   - a. Comply with established company and OSHA regulations
   - b. Interpret safety manual directives
   - c. Wear safety/protective equipment as required
2. Maintain Safe Equipment and Machinery
   - a. Maintain equipment/tooling in safe operating condition
   - b. Maintain all guards, shields, and barriers in place and in good condition
   - c. Perform preventive maintenance as required
   - d. Practice proper tag-out/lock-out procedures
3. Maintain a Clean and Safe Work Environment
   - a. Keep work areas clean and free of debris
   - b. Keep isles/traffic areas clear of equipment and materials
   - c. Store materials, tools, and instruments in organized manner
   - d. Clean machine/hand tools when work is complete
4. Use Safe Operating Procedures for Hand and Machine Tools
   - a. Use tools for intended purposes only
   - b. Acquire proper training/authorization before operating equipment
   - c. Operate hand and machine tools in safe manner
   - d. Comply with manufacturer's rated capacity for equipment
   - e. Ensure all rotating or moving parts have stopped before leaving area
   - f. Inspect for and remove possible hazards before engaging equipment
5. Use Safe Machining Practices
   - a. Ensure stock/tooling is secure before machining
   - b. Use chip control methods
   - c. Use moderate, safe, and calculated speeds and feeds

d. Stay alert and prepared to act during machining
e. Ensure rotating parts/tooling are completely stopped before handling

6. Use Safe Lifting Practices
   a. Use lifting aids when necessary
   b. Use OSHA approved chains, straps, and hoists
   c. Comply with rated capacity of lifting equipment
   d. Comply with company/OSHA regulations regarding lifting procedures
7. Consult and Apply MSDS for Hazards of Various Materials
   a. Know format of material safety data sheets
   b. Consult and interpret MSDS to determine relevant hazards of material
   c. Apply information and take precautionary measures against hazards
   d. Notify proper authorities of hazards

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Arithmetic Functions
   a. Add, subtract, multiply, and divide whole numbers
   b. Add, subtract, multiply, and divide fractions
   c. Add, subtract, multiply, and divide decimals
   d. Interconvert fractions/decimals
   e. Interconvert metric/English measurements
2. Perform Basic Algebraic Operations
   a. Evaluate equation using standard algebraic hierarchy
   b. Solve equations with one unknown variable
   c. Solve ratio/percentage problems
   d. Calculate and apply formulas
3. Perform Basic Trigonometric Functions
   a. Solve for unknown sides/angles of right triangles using trigonometric functions
   b. Solve for unknown side of right triangle using Pythagorean's Theorem
4. Use and Apply Cartesian Coordinate System
   a. Define the Cartesian coordinate system
   b. Calculate coordinates of bolt circle on Cartesian coordinate system
   c. Plot machining points using Cartesian coordinate system

C. DEMONSTRATE QUALITY CONTROL AND MANAGEMENT

1. Utilize Appropriate Inspection Techniques
   a. Discuss factors that affect accurate measurement
   b. Determine proper procedure to acquire accurate measurement
   c. Determine proper instrument to use in measurement
2. Perform Appropriate Use and Calibration of Inspection Equipment
   a. Explain calibration requirements of various precision instruments
   b. Maintain/care for instruments for optimum performance
   c. Read and use O.D., I.D., and depth micrometers
   d. Read and use vernier, dial, & digital calipers
   e. Read and use scale and tape measure
   f. Read and use dial-bore indicators
   g. Use dial indicators
   h. Use precision square and combination set
   i. Read and use digital read-out

j. Use finish/profile gages
k. Use Rockwell hardness tester
l. Know operation of coordinate measuring machine (CMM)
m. Use surface plates

3. Know Qualitative Parameters of Machinery and Equipment
   a. Differentiate between types of machinery by qualitative capabilities
   b. Select appropriate processes to maintain desired tolerances
   c. Discuss the effect one process might have on an earlier or later process
4. Maintain Equipment to Produce Quality Parts
   a. Justify tooling by qualitative requirements
   b. Protect/maintain critical surfaces of machines
   c. Perform preventive maintenance on equipment
5. Know and Use Quality Systems
   a. Know and use ISO 9000 concepts and procedures
   b. Know and use Statistical Process Control (SPC) techniques and concepts
6. Write Inspection Procedures
   a. Determine/designate proper inspection technique
   b. Determine/designate precautions to take during inspection
   c. Determine/design inspection jig or fixture required
   d. List in order and define steps required to ensure accurate measurement
7. Document Inspection Results
   a. Define procedure used during inspection
   b. Accurately document measurements taken and compare to standard
   c. Determine/document if part passes or fails inspection
   d. Determine/document rework or scrap recommendations

D. DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS

1. Identify Materials with Desired Properties
   a. Determine/identify service requirements (strength, hardness, etc.)
   b. Determine, interpret, and evaluate availability of materials
   c. Describe general characteristics of various metals
   d. Know concepts of/calculate statics and stresses
2. Demonstrate Knowledge of Physical Properties of Materials
   a. Define hardness
   b. Define toughness
   c. Define tensile strength
   d. Define shear strength
   e. Define elasticity
   f. Define ductility
   g. Discuss the Rockwell and Brinell hardness scales
   h. Discuss the Charpy/Izod impact tests
3. Identify Manufacturing Properties of Materials
   a. Discuss machinability of various materials
   b. Discuss cold forming/workability of various materials
   c. Define work hardening/edge hardening
   d. Identify welding properties of various materials
   e. Demonstrate knowledge of heat treating procedures and properties
   f. Know stress relieving procedures

g. Know/Find hardness characteristics and chemistry of various materials

4. Discuss Classification System for Metals
   a. Identify and discuss types of carbon steel
   b. Determine chemistry of material by classification
   c. Distinguish between SAE and AISI classification systems
   d. Identify designation of each digit of steel classification
   e. Discuss alloy steels

E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES

1. Know Operation of Vertical and Horizontal Mills and Tooling
   a. Define milling machines, horizontal and vertical
   b. List, describe, and give function and maintenance of different types of tooling used on milling machines
   c. Set-up and operate horizontal and vertical milling machine
   d. Explain machine components and accessories of milling machines
   e. Explain milling processes
   f. Discuss milling machine safety
   g. Discuss CNC machining centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC machining center
2. Know Operation of Engine and Turret Lathes and Tooling
   a. Define lathes, engine and turret
   b. List, describe, and give function and maintenance of various types of tooling used on lathes
   c. Set-up and operate engine and turret lathes
   d. Explain machine components and accessories of lathes
   e. Explain turning processes
   f. Discuss lathe safety
   g. Discuss CNC turning centers and processes
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC turning center
3. Know Operation of Drill Presses and Tooling
   a. Identify types of drilling machines
   b. List, describe, and give function and maintenance of various types of tooling used on drilling machines
   c. Set-up and operate drilling machines
   d. Explain machine components and accessories of drilling machines
   e. Explain processes performed on drilling machines
   f. Discuss drilling safety
   g. Discuss drilling operations on CNC drilling machines
   h. Calculate speeds and feeds based on materials and tooling
   i. Set-up and operate CNC drilling machine
4. Know Operation of Surface and Cylindrical Grinders
   a. Define grinders, surface and cylindrical
   b. Explain types and maintenance of grinding wheels
   c. Set-up and operate grinding machines
   d. Explain machine components and accessories of grinding machines
   e. Explain grinding processes

f. Discuss grinding safety

5. Know Operation of Heat Treating Equipment and Processes
   a. Describe types of heat treating equipment
   b. Set-up and operate heat treating equipment
   c. Explain machine components and accessories of heat treating equipment
   d. Explain heat treating procedures
   e. Discuss heat treating safety
6. Know Operation of Welding Equipment and Processes
   a. Identify various types of welding equipment
   b. Identify and discuss the difference in welding processes
   c. Inspect welds for cracks and penetration
   d. Discuss welding safety
7. Know Sheet Metal Operations
   a. Discuss gas/plasma cutting equipment and processes
   b. Discuss operation of punch/brake presses and tooling
   c. Discuss operation of plate shears
   d. Calculate tonnages required for press/shear operations
   e. Calculate blank dimensions of developed parts
   f. Use yield tables for bending sheet metal
   g. Discuss fabrication of sheet metal parts
   h. Demonstrate layout-on-metal
   i. Apply conservation-of-material concepts
8. Know Operation of Jig-boring Machines and Tooling
   a. Define jig-boring machine
   b. List, describe, and give function and maintenance of different types of tooling used on jig-boring machines
   c. Set-up and operate jig-boring machine
   d. Explain machine components and accessories of jig-boring machines
   e. Explain jig-boring process
   f. Discuss safety on jig-boring machine
   g. Calculate speeds and feeds based on materials and tooling
9. Know Operation of Tool and Cutter Grinders
   a. Define tool/cutter grinder
   b. Discuss dressing and maintenance of grinding wheels
   c. Explain machine components and accessories of tool/cutter grinder
   d. Discuss tool and cutter grinder safety
10. Know Operation of Metal Saws
   a. Define band saw, horizontal and vertical
   b. Set-up and operate band saw
   c. Define abrasive cut-off saw
   d. Set-up and operate abrasive cut-off saw
   e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades
   f. Weld and maintain band saw blade
   g. Discuss band saw safety
   h. Calculate speeds and feeds based on materials and tooling
   i. Explain machine components and accessories of band saws

j. Calculate proper length of band saw blade

11. Know Operation of Wire EDM
    a. Define EDM
    b. Explain EDM process
    c. Set-up and operate CNC wire EDM
    d. Discuss EDM safety
    e. Calculate E-pac value for wire EDM
    f. Explain machine components and accessories of wire EDM
12. Estimate Time Required/Cost to Produce a Part
    a. Determine processes required to produce part
    b. Calculate actual machining and handling time
    c. Calculate material quantity and cost
    d. Calculate labor and overhead cost
13. Know Proper Flow of Parts Through Shop
    a. Discuss proper order of processes
    b. Discuss ergonomic aspects of plant layout
14. Utilize Concepts and Principles of Fixturing
    a. Determine need for fixture/jig
    b. Design appropriate fixture/jig
    c. Identify components used in fixtures/jigs
    d. Disassemble and assemble fixture/jig
    e. Discuss relationship between accuracy of fixture and accuracy/repeatability of parts
15. Make Calculations for and Use Sine Bar/Sine Plate
    a. Define sine bar/sine plate
    b. Calculate gage block buildup for sine bar/sine plate
    c. Set-up and use sine bar/sine plate
16. Make Calculations for and Use Rotary Table and Dividing Head
    a. Set-up and use rotary table/dividing head for machining operations
    b. Make calculations for number of rotations required
    c. Determine/select appropriate index plate for dividing head

F. PERFORM CNC PROGRAMMING/CAM TASKS

1. Prepare and Plan for CNC Machining Operations
    a. Plan sequence of machining events
    b. Determine proper tooling/fixtures required for machining
    c. Calculate speeds, feeds, and depth-of-cut for machining
    d. Explain the x, y, and z axis on CNC machines
2. Select and Use Tooling Systems for CNC Machines
    a. Understand machinability and chip formation
    b. Select proper insert materials and geometry
    c. Select proper tooling system
    d. Define and discuss application of HSS, carbide, and borazon cutting tools
3. Manually Program CNC Machines
    a. Plan and write programs for CNC machines
    b. Use MDI panel on machine to program/edit programs
    c. Set and use tooling offsets at CNC machine
    d. Discuss/use canned or bar cycles in program

4. Use Computer-Aided Manufacturing (CAM) System
    a. Create toolpath geometry using CAM system
    b. Interconvert CAD and CAM files using acceptable exchange format
    c. Transfer files from CAM system to machine
    d. Configure CAM system parameters

G. DEMONSTRATE COMMUNICATION SKILLS

1. Use Written Correspondence
    a. Read, write, interpret, and apply memorandums
    b. Read, write, interpret, and apply business letters
    c. Read, write, interpret, and apply written instructions
2. Use Written Technical Information
    a. Read, write, interpret, and apply technical reports
    b. Read, write, interpret, and apply written procedures
    c. Read, write, interpret, and apply technical manuals
3. Communicate Technical Information Verbally
    a. Demonstrate ability to listen to and understand verbal technical information/instructions
    b. Ask appropriate questions to ascertain needed information
    c. Demonstrate ability to give verbal technical information/instructions
4. Use Graphics for Visual Aid
    a. Create, read, and apply graphs
    b. Create, read, and apply charts
    c. Create, read, and apply graphical illustrations

H. PERFORM DRAFTING/CAD TASKS

1. Demonstrate Traditional Mechanical Drafting Skills
    a. Demonstrate use of drafting machine and instruments
    b. Demonstrate drafting technique to create basic geometric elements
    c. Demonstrate isometric sketching of objects
    d. List and apply the three primary planes of projection
    e. List and apply the six principle views
    f. Use and apply auxiliary views
    g. Create sectional views
2. Use Computer-Aided Drafting (CAD) System
    a. Create geometry using CAD system
    b. Create 3-D solid models
    c. Interconvert CAD and accepted drawing exchange formats
    d. Use peripheral devices
3. Use and Apply Geometric Dimensioning and Tolerancing (GD&T) Methodology
    a. Distinguish between conventional and geometric dimensioning and tolerancing.
    b. Explain and use geometric positional tolerancing
    c. Explain and use tolerances of form
    d. Explain and use the feature control symbol
    e. Explain and use modifiers in geometric dimensioning and tolerancing

I. USE COMPUTERS

1. Use Computer Operating Systems
    a. Use Windows

b. Use computer network system

2. Use File Management Systems
   a. Discuss file management concepts
   b. Create/remove directories
   c. Copy files from floppy disks to hard drive

J. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS

1. Interpret, Review, and Apply Blueprint Notes, Dimensions, and Tolerances
   a. Distinguish between general and specific notes
   b. Interpret and apply general and specific notes
   c. Determine and apply dimensions on a drawing
   d. Identify basic symbols found on a drawing
   e. Identify tolerances on a drawing
   f. Discuss GD&T methodology
2. Interpret and Understand Basic Layout/Types of Drawings
   a. Identify types of drawings
   b. Identify parts of a drawing and list components of each
   c. Identify types of lines on a drawing
   d. List and describe the different views found on a drawing
3. Understand and Analyze Bill-of-Materials
   a. Determine materials required
   b. Determine quantities required
   c. Identify item symbol and/or part number
4. Ascertain Job Requirements from Drawings
   a. Interpret part requirements
   b. Identify surfaces to be machined
   c. Determine critical dimensions

K. PERFORM DIE OPERATIONS

1. Utilize Basic Die Theory and Principles of Die Design
   a. Discuss shearing action on metal (3 stages)
   b. Define/calculate cutting clearance
   c. Define/calculate proper shut-height of die set
   d. Define/calculate offset displacement
   e. Define/calculate stripping pressure
   f. Define/calculate cutting length of piece part
   g. Define/calculate die progression
   h. Design stock strip layout
   i. Determine die feed direction
   j. Explain notch, pierce, pilot, form, and cut-off stations
   k. Determine stop block length
   l. Determine press tonnage requirements
   m. Define/calculate slug clearance
   n. Explain operation of die set to make piece part
   o. Explain spring back in form dies
   p. Explain bending action in V-form dies
   q. Explain coining in dies
   r. Identify components of die set
   s. Discuss materials of die components

2. Perform Die Repair
   a. Disassemble and assemble die set
   b. Visually inspect die components for damage
   c. Identify component parts to be repaired/sharpened
   d. Determine method of repairing/sharpening
   e. Determine material for replacement parts
   f. Manufacture replacement parts
   g. Demonstrate setting correct punch entry
3. Demonstrate Die Making Skills
   a. Identify component parts from die blueprint
   b. Determine material/purchased parts requirements
   c. Utilize die making procedures to make component parts
   d. Utilize die making procedures to mount component parts
   e. Demonstrate mounting of die set in press machine
   f. Cycle die set in press machine and inspect operation
   g. Inspect piece part for accuracy
4. Demonstrate Understanding of Different Types of Industrial Dies
   a. Describe the operation and major components of blanking or piercing dies
   b. Describe the operation and major components of bending or forming dies
   c. Describe the operation and major components of draw dies
   d. Describe the operation and major components of compression dies
   e. Describe the operation and major components of progressive dies
   f. Describe the operation and major components of compound dies
   g. Describe the operation and major components of combination dies

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

The following activities will be performed by each student for successful completion of this course:

I. **COMPETENCIES**
   A. Resources: Identifies, organizes, plans, and allocates resources
      1. allocates time to complete assigned tasks on schedule
      2. determines cost associated with meeting objectives
      3. determines and allocates required materials and resources for meeting objectives
      4. evaluates skills, performance, and quality of work and provides feedback
   B. Interpersonal: Works with others

1. participates as a member of the team, contributing to group effort
2. provides individual assistance/direction to peers as requested
3. determines and meets internal and external customers' expectations
4. exercises leadership qualities to effectively communicate ideas and make decisions
5. negotiates resources in order to accomplish objectives
6. works well with all members of the class

C. ***Information:*** *Acquires and uses information*
1. acquires and evaluates information
2. organizes and maintains information
3. interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*
1. understands and works well with social, organizational, and technological systems
2. monitors and corrects performance of system during operation
3. recommend modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*
1. chooses relevant procedures, tools and equipment
2. applies appropriate procedures and techniques to accomplish tasks
3. identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. ***Basic Skills:*** *Reads, writes, performs arithmetic and mathematical operations, listens and speaks.*

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percents
   b. demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. demonstrates ability to understand and perform multi-step computations
   d. demonstrates ability to read, interpret, and use standard measuring devices
   e. demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. demonstrates ability to hear, comprehend, and appropriately follow directions
   c. demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. demonstrates appropriate listening and speaking skills in personal conversations

b. demonstrates ability to choose and organize appropriate words to effectively communicate
c. demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. demonstrates ability to take responsibility for presentations

B. ***Thinking Skills:*** *Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons.*

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. demonstrates ability to objectively assess personal strengths and weaknesses
b. demonstrates ability to set realistic short-term and long-term goals
c. demonstrates ability to recognize and distinguish between positive and negative alternatives
d. demonstrates ability to identify potential pitfalls and take evasive actions
e. demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. demonstrates maturity to take responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. demonstrates ability to detect problem through observation, inquiry, or directive
b. demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. demonstrates ability to generate alternatives or options for problem solution
d. demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. demonstrates ability to initiate and effect solution
f. demonstrates ability to take responsibility for outcomes
g. demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
b. demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. demonstrates ability to visually discriminate in gross and fine imagery
d. demonstrates ability to visualize abstractly
e. demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of basic reading, math, and language skills through application
   b. demonstrates ability to translate abstract theory into practical application
   c. demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. demonstrates use of simple logic
   b. demonstrates ability to distinguish relationships
   c. demonstrates ability to determine and isolate factors in relationships
   d. demonstrates and applies knowledge through practice
   e. recognizes that attitudes, skills, and practice are essential to productivity
   f. demonstrates ability to discriminate between positive and negative, and act accordingly

C. ***Personal Qualities:*** *Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty.*

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. demonstrates ability to focus on task at hand and work to completion
   d. demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. demonstrates maturity to take responsibility for actions
   f. demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** Believes in own self-worth and maintains a positive view of self
   a. presents a positive attitude toward tasks

b. demonstrates ability to separate work and personal behaviors
c. actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. demonstrates ability to accept and use constructive criticism
f. accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. demonstrates appropriate and acceptable social behaviors in classroom interactions
   b. demonstrates ability to work cooperatively in individual, team, or group situations
   c. demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. accepts personal strengths and weaknesses and uses the same for positive advancement
   b. demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. demonstrates ability to formulate and follow personal schedules
   d. demonstrates ability to wisely use classroom time
   e. demonstrates use of good study habits and skills
   f. demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. knows and demonstrates ability to distinguish between positive and negative behaviors
   b. demonstrates honesty and integrity in working with peers and supervisors
   c. takes full responsibility for personal actions
   d. demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Die Design Fundamentals, J. R. Pacquin and R.E. Crowley, 2nd Ed.

APPENDIX A - INDUSTRY COMPETENCY PROFILES

The following pages contain the individual Competency Profiles for each of the companies surveyed by the MAST development center for the occupational specialty area of . These Competency Profiles/skill standards were used to develop the curriculum for the pilot program.

The participation of the companies as partners in the MAST effort is greatly appreciated. Each company has approved the use of its logo in MAST materials. None of the participating companies shall be held responsible or liable for any of the findings of the project.

SKILLS AND KNOWLEDGE

Communication Skills
Technical Reading/Writing Skills
Ability to Comprehend Written/Verbal Instructions
Leadership Skills
Organizational Skills
Knowledge of Company Policies/Procedures
Knowledge of Employee/Employer Responsibilities
Ability to Work as Part of a Team
Knowledge of Company Quality Assurance Activities
Knowledge of Safety Regulations/Responsibilities
Project/Task Management Skills
Logical/Systematic Problem Solving Skills
Computer Skills
Numerical/Mathematical Skills
Use Measurement Tools
Use Inspection Devices
Drafting Skills
Knowledge of Industrial Materials
Knowledge of Manufacturing Processes
Mechanical Aptitude

ITAWAMBA COMMUNITY COLLEGE MAST PROGRAM REPRESENTATIVES

Dr. Charles Chrestman
Dean/Director

Don Benjamin
Associate Dean/Site Administrator

Barry Emison
Site Coordinator

AIRCAP/MTD REPRESENTATIVES

Charles Aldridge
Tool & Die Maker

Ron Bateman
Tool & Die Manager

Nathan Hughes
Tool & Die Supervisor

Barry Ledbetter
Tool & Die Maker

Todd Shields
Tool & Die Maker

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Personal Ethics
Innovative

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators
magnetic tool holders, etc.)
Measuring Tools
Metal Layout Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Band Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment
CNC Machining Center and Turning Center
Jig Boring Machines
Alignment/Calibration Tools
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Composites
In-Process Gauging
Rapid Tool Changing
Expanded Communication with Shop Floor
Multi-Axis Equipment
Computer-Integrated Manufacturing
Adaptive Controls
Conversational Programming
Artificial Intelligence

COMPETENCY PROFILE

Tool & Die Maker

Prepared By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortia Partners
(V.199J40008)

AIRCAP/MTD

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machines and produce a variety of products

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Maintain a clean and safe work environment	A-4 Ensure safe operation of machines	A-5 Use safe machining practices	A-6 Use safe lifting practices	A-7 Use safe operating procedures for hand and machine tools	A-8 Consult and apply MSDS for hazards of various materials	A-9 Practice proper tag-out/ lock-out procedures	A-10 Practice electrical safety procedures			
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Interconvert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Use basic geometric principles	B-7 Calculate and apply formulas	B-8 Use and apply basic concepts of technical physics					
C Demonstrate Quality Control and Management	C-1 Maintain equipment to produce quality parts	C-2 Perform appropriate use and calibration of inspection equipment	C-3 Know qualitative parameters of machinery and equipment	C-4 Know operation of coordinate measuring machine									
D Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Know machinability/ workability of various materials	D-3 Apply concepts of and calculate statics and stresses	D-4 Know/Find hardness characteristics/ chemistry of various material	D-5 Demonstrate knowledge of heat treating procedures and properties	D-6 Know stress relieving procedures		D-8 Determine, interpret, and evaluate availability of materials					
E Demonstrate Knowledge of Manufacturing Processes	E-1 Know operation of vertical and horizontal mills and tooling	E-2 Know operation of engine and turret lathes and tooling	E-3 Know operation of drill presses and tooling	E-4 Know operation of surface and cylindrical grinders	E-5 Know operation of heat treating equipment	E-6 Know operation of welding equipment	E-7 Know operation of gas cutting equipment	E-8 Know operation of punch / brake presses and tooling	E-9 Know operation of band and radial arm saws	E-10 Know operation of jig-boring machines and tooling	E-11 Know operation of tool and cutter grinders	E-12 Make calculations for rotary table and dividing head	E-13 Make calculations for sine bar/plate
	E-14 Utilize concepts and principles of fixturing	E-15 Have knowledge of CNC programming language	E-16 Calculate tonnages required for press operations	E-17 Calculate bend allowances / use yield tables for sheet metal operations	E-18 Apply conservation of material concepts	E-19 Calculate speeds and feeds based on materials and tooling							
F Perform CNC Programming/ CAM Tasks	F-1 Prepare and plan for CNC machining operations	F-2 Select, use, and acquire tooling systems for CNC machines	F-3 Manually program CNC machines	F-4 Set and use tooling offsets at CNC machine	F-5 Use Computer-Aided-Manufacturing (CAM) system	F-6 Transfer files from CAM system to machine	F-7 Interconvert CAD and CAM files using DXF or IGES formats	F-8 Install and maintain file transfer systems	F-9 Configure CAM system parameters				
G Perform Measurement/ Inspection	G-1 Know operation of O.D., I.D., and depth micrometers	G-2 Know operation of vernier, dial, & digital calipers	G-3 Read and use scale and tape measure	G-4 Know operation of dial-bore indicators	G-5 Know operation of dial indicators	G-6 Use precision square, center head, and protractor	G-7 Use digital read-out	G-8 Use finish/ profile gauges	G-9 Know operation of Rockwell hardness tester				
H Demonstrate Communication Skills	H-1 Read, interpret, and apply memorandums, letters, and written instructions	H-2 Read, interpret, and apply technical reports, procedures and manuals	H-3 Communicate technical information verbally	H-4 Read, interpret, and apply graphs, charts, and other visual aids									
I Perform Drafting/CAD Tasks	I-1 Demonstrate traditional mechanical drafting skills	I-2 Use Computer-Aided Drafting (CAD) system	I-3 Create 3-D solid models	I-4 Use and apply GD&T methodology	I-5 Generate and/or apply industry or company standards	I-6 Interconvert CAD and DXF or IGES formats	I-7 Configure CAD system parameters						

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Duties	Tasks												
J — Use Computers	J-1 Use computer operating systems	J-2 Use file management systems	J-3 Understand RS-232 protocol	J-4 Install/use software packages	J-5 Use computer network system	J-6 Use file transfer systems							
K — Participate in Product Design Activities	K-1 Design parts for manufacturability	K-2 Plan and design for "mating of parts"	K-3 Be cost conscious with design of parts	K-4 Determine, interpret, and evaluate customer specifications									
L — Interpret/Use Blueprints and Related Documents	L-1 Interpret, review, and apply blueprint notes, dimensions, and tolerances	L-2 Interpret and understand basic layout/ types of drawings	L-3 Understand and analyze bill of materials	L-4 Ascertain job requirements from drawings	L-5 Interpret and apply geometric dimensioning and tolerancing								
M — Manage Projects/Tasks	M-1 Comprehend entire scope of project	M-2 Conduct multiple project management	M-3 Set and maintain timelines	M-4 Prioritize tasks/duties/ projects	M-5 Preplan project activities	M-6 Demonstrate time/resource management							
N — Perform Die Operations	N-1 Utilize basic die theory	N-2 Visually inspect die components for damage	N-3 Disassemble and assemble die set	N-4 Determine proper cutting, clearance, and slug relief	N-5 Calculate proper shut-height of die set	N-6 Design stock strip layout	N-7 Determine press tonnage requirements	N-8 Calculate stripping pressures					

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

SPRINGFIELD TECHNICAL COMMUNITY COLLEGE MAST PROGRAM REPRESENTATIVES

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Mechanical Engineering Technology

NICK M. MASSA
Director of Technology Development

ROSE MARY TIMMONS
Senior Secretary/Statistician (TSTC)

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AMERICAN SAW & MFG. CO.

Mike Lyons
Ted Henderer
George Zades
Peter Lasklewicz
Scott Brukins
Ron Boutin
Al Walder

SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE

Tool & Die Maker

Prepared By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortia Partners
(V.199J40008)

SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

LENOX®

TOOL & DIE MAKER.... analyze variety of specifications, lay out metal stock, set up and operate machine tools, and fit and assemble parts to make and repair dies, cutting tools, jigs, fixtures, gages, and machinist's hand tools.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Locate machining points from a datum point	B-3 Inter-convert fractions/ decimals	B-4 Inter-convert Metric/ English measurements	B-5 Perform basic trigonometric functions	B-6 Use sine bar or sine plate for machine operations	B-7 Calculate for direct, simple, and angular indexing	B-8 Calculate speeds and feeds for machining					
C Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Identify lines and symbols (GD&T)	C-7 Analyze Bill of Materials (BOM)	C-8 Understand and use quality systems	C-9 Create technical sketches				
D Select Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Identify heat treating processes	D-3 Perform heat treating operations	D-4 Test metal samples for hardness	D-5 Evaluate alternative manufacturing processes								
E Perform Measurement and Inspection	E-1 Study basics of metrology	E-2 Select instruments used for measurement	E-3 Interpret limits and tolerances	E-4 Select gagging tools	E-5 Use CMM for location of features	E-6 Perform surface metrology	E-7 Perform measurement by comparison	E-8 Perform circularity, cylindricity, profile of a line, and runout measurements	E-9 Investigate advanced metrology topics				
F Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/ abrasive machines	F-9 Operate deburring equipment	F-10 Polish mold/die cavities			
G Perform Advanced Machining Processes	G-1 Program Computer Numerical Control (CNC) machines	G-2 Operate CNC machining centers and turning centers	G-3 Program CNC machine with a CAM system										
H Build/Modify/ Repair Tools	H-1 Interpret tool drawings	H-2 Build/ modify/repair drill jigs	H-3 Build/ modify/repair mill fixtures	H-4 Build/ modify/repair dies	H-5 Build/ modify/repair patterns/ templates								
I Use Computers	I-1 Use computer operating systems	I-2 Use computer inquiry systems	I-3 Use Computer-Aided Drafting (CAD) software										
J Maintain Hydraulic/ Pneumatic Devices	J-1 Use test equipment	J-2 Describe basic principles of hydraulic systems	J-3 Identify hydraulic fluids	J-4 Recommend power distribution and sealing devices	J-5 Recognize pumps, actuators, and hydraulic control devices	J-6 Troubleshoot hydraulic/pneumatic systems							

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SKILLS AND KNOWLEDGE

Communication Skills
Technical Reading/Writing Skills
Ability to Comprehend Written/Verbal Instructions
Leadership Skills
Organizational Skills
Knowledge of Company Policies/Procedures
Knowledge of Employee/Employer Responsibilities
Ability to Work as Part of a Team
Knowledge of Company Quality Assurance Activities
Knowledge of Safety Regulations/Responsibilities
Project/Task Management Skills
Logical/Systematic Problem Solving Skills
Computer Skills
Numerical/Mathematical Skills
Use Measurement Tools
Use Inspection Devices
Drafting Skills
Knowledge of Industrial Materials
Knowledge of Manufacturing Processes
Mechanical Aptitude

ITAWAMBA COMMUNITY COLLEGE MAST PROGRAM REPRESENTATIVES

Dr. Charles Chrestman
Dean/Director

Don Benjamin
Associate Dean/Site Administrator

Barry Emison
Site Coordinator

DELTA REPRESENTATIVES

Gary Carroll
Tool Room/Crib Supervisor

Tony Nichols
Tool Engineer

Delwyn Pounders
Sr. Tool Engineer

Jim Wright
Sr. Tool Engineer

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Personal Ethics
Innovative

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators
magnetic tool holders, etc.)
Measuring Tools
Metal Layout Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Band Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment
CNC Machining Center and Turning Center
Jig Boring Machines
Alignment/Calibration Tools
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Rapid Tool Changing
Expanded Communication with Shop Floor
Multi-Axis Equipment
Computer-Integrated Manufacturing

COMPETENCY PROFILE

Tool & Die Maker

Prepared By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortia Partners
(V.199J40008)

DELTA
A Pentair Company

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machines and produce a variety of products

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Maintain a clean and safe work environment	A-4 Ensure safe operation of machines	A-5 Use safe machining practices	A-6 Use safe lifting practices	A-7 Use safe operating procedures for hand and machine tools	A-8 Consult and apply MSDS for hazards of various materials	A-9 Practice proper tag-out/ lock-out procedures	A-10 Practice electrical safety procedures			
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Interconvert fractions/ decimals	B-3 Interconvert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Use basic geometric principles	B-7 Use and apply cartesian coordinate system						
C Demonstrate Quality Control and Management	C-1 Maintain equipment to produce quality parts	C-2 Perform appropriate use and calibration of inspection equipment	C-3 Know qualitative parameters of machinery and equipment	C-4 Know and use ISO 9000 concepts and procedures									
D Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Know machinability/ workability of various materials	D-3 Know and apply lubrication techniques and fluids for machining	D-4 Know/Find hardness characteristics/ chemistry of various material	D-5 Demonstrate knowledge of heat treating procedures and properties	D-6 Know stress relieving procedures		D-8 Determine, interpret, and evaluate availability of materials					
E Demonstrate Knowledge of Manufacturing Processes	E-1 Know operation of vertical and horizontal mills and tooling	E-2 Know operation of engine and turret lathes and tooling	E-3 Know operation of drill presses and tooling	E-4 Know operation of surface and cylindrical grinders	E-5 Know operation of heat treating equipment and processes	E-6 Know operation of welding equipment	E-7 Know operation of gas cutting equipment	E-8 Know operation of punch / brake presses and tooling	E-9 Know operation of band and radial arm saws	E-10 Know operation of jig-boring machines and tooling	E-11 Know operation of tool and cutter grinders	E-12 Know operation of plate shears	E-13 Know operation of tool and cutter grinders
	E-14 Utilize concepts and principles of fixturing	E-15 Calculate speeds and feeds based on materials and tooling	E-16 Make calculations for rotary table and dividing head	E-17 Make calculations for sine bar/plate	E-18 Apply conservation of material concepts	E-19 Schedule preventive maintenance for tooling and/or machines							
F Perform CNC Programming/ CAM Tasks	F-1 Prepare and plan for CNC machining operations	F-2 Select, use, and acquire tooling systems for CNC machines	F-3 Manually program CNC machines	F-4 Set and use tooling offsets at CNC machine									
G Perform Measurement/ Inspection	G-1 Know operation of O.D., I.D., and depth micrometers	G-2 Know operation of vernier, dial, & digital calipers	G-3 Read and use scale and tape measure	G-4 Know operation of dial-bore indicators	G-5 Know operation of dial indicators	G-6 Use precision square, center head, and protractor	G-7 Use digital read-out	G-8 Use finish/ profile gauges	G-9 Know operation of Rockwell hardness tester				
H Demonstrate Communication Skills	H-1 Read, interpret, and apply memorandums, letters, and written instructions	H-2 Read, interpret, and apply technical reports, procedures and manuals	H-3 Communicate technical information verbally										
I Interpret/Use Blueprints and Related Documents	I-1 Interpret, review, and apply blueprint notes, dimensions, and tolerances	I-2 Interpret and understand basic layout/ types of drawings	I-3 Understand and analyze bill of materials	I-4 Ascertain job requirements from drawings	I-5 Interpret and apply geometric dimensioning and tolerancing	I-6 Interpret and apply hydraulic and/ or pneumatic diagrams							

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Duties ← **Tasks** →

Duties													
J	**Perform Die Operations**	J-1 Utilize basic die theory	J-2 Visually inspect die components for damage	J-3 Disassemble and assemble die set	J-4 Determine proper cutting, clearance, and slug relief	J-5 Calculate proper shut-height of die set							
K	**Manage Projects/Tasks**	K-1 Comprehend entire scope of project	K-2 Assess and evaluate/ revise or modify project methodology	K-3 Set and maintain timelines	K-4 Prioritize tasks/duties/ projects	K-5 Preplan project activities	K-6 Demonstrate time/resource management						

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO
MAST PROGRAM REPRESENTATIVES

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Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

FRED YAGOW

VINCE GEHRIN
Specialist, Technical Training

Texas State Technical College Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE

Tool & Die Maker

Prepared By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

Texas State Technical College Waco

MCDONNELL DOUGLAS

TOOL & DIE MAKER.... analyze variety of specifications, lay out metal stock, set up and operate machine tools, and fit and assemble parts to make and repair dies, cutting tools, jigs, fixtures, gages, and machinist's hand tools.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment	A-5 Use proper chemical protection equipment								
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Locate machining points from a datum point	B-3 Inter-convert fractions/ decimals	B-4 Inter-convert Metric/ English measurements	B-5 Perform basic trigonometric functions	B-6 Use sine bar or sine plate for machine operations	B-7 Calculate for direct, simple, and angular indexing	B-8 Calculate speeds and feeds for machining	B-9 Calculate draft angle dimensions				
C Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Identify lines and symbols (GD&T)	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify require-ments	C-9 Under-stand and use quality systems				
D Select Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Identify heat treating processes	D-3 Perform heat treating operations	D-4 Test metal samples for hardness with Rockwell method									
E Perform Measurement/ Inspection	E-1 Identify types of measurement	E-2 Select proper measurement tools	E-3 Apply proper measur-ing techniques	E-4 Measure with hand held instruments	E-5 Measure/ layout/inspect using surface plate	E-6 Inspect using stationary equipment	E-7 Use Laser measuring devices						
F Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/ abrasive machines	F-9 Operate jig boring machines	F-10 Operate deburring equipment	F-11 Polish mold/die cavities	F-12 Operate tool and cutter grinders	
G Perform Advanced Machining Processes	G-1 Program Computer Numerical Control (CNC) machines	G-2 Operate CNC machining centers and turning centers	G-3 Operate electrical discharge machines	G-4 Use water jet cutter and superabrasive applications									
H Build/Modify/ Repair Tools	H-1 Interpret tool drawings	H-2 Build/ modify/repair drill jigs	H-3 Build/ modify/repair mill fixtures	H-4 Build/ modify/repair dies	H-5 Build/ modify/repair patterns/ templates	H-6 Perform on line maintenance							
I Use Computers	I-1 Use computer operating systems	I-2 Use various computer applications	I-3 Use computer inquiry systems	I-4 Use Computer Aided Drafting (CAD) software	I-5 Use Diodelite system								
J Work With Sheet Metal Structures	J-1 Install special rivets and fasteners	J-2 Inspect bonded structures	J-3 Inspect and repair plastics, honeycomb and laminated structures	J-4 Inspect, check, service, and repair windows, doors and interior finishings	J-5 Inspect and repair sheet metal structures	J-6 Remove and install conventional rivets	J-7 Hand form, layout and bend sheet metal						

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Duties ← **Tasks** →

K Work with Composite Structures

K-1 Determine extent of damage	K-2 Identify method of repair/standard repair method (SRM)	K-3 Identify bill of materials (BOM)	K-4 Repair per technical order/ engineer specification or disposition	K-5 Perform metal to metal repair	K-6 Perform composite to metal repair	K-7 Perform resin transfer molding	K-8 Lay-up a fiberglass mold	K-9 Build honeycomb structure to specification	K-10 Prepare surfaces for bonding	K-11 Perform hot bonding	K-12 Perform cold bonding	K-13 Install a boron patch
K-14 Conduct non-destructive inspection (NDI)	K-15 Perform simultaneous sample testing											

SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

TEXAS STATE TECHNICAL COLLEGE WACO MAST PROGRAM REPRESENTATIVES

DR. HUGH ROGERS
Director

DR. JON BOTSFORD
Assistant Director

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

REED TOOL COMPANY REPRESENTATIVE

FRED DREGER
Supervisor

HAROLD LAIRD
Die Maker

Texas State Technical College Waco

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE
Tool & Die Maker

Conducted By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortia Partners
(V.199J40008)

Texas State Technical College Waco

REED TOOL COMPANY
A SUBSIDIARY OF CAMCO

TOOL & DIE MAKER.... **analyze variety of specifications, lay out metal stock, set up and operate machine tools, and fit and assemble parts to make and repair dies, cutting tools, jigs, fixtures, gages, and machinist's hand tools.**

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Locate machining points from a datum point	B-3 Interconvert fractions/ decimals	B-4 Interconvert Metric/English measurements	B-5 Perform basic trigonometric functions	B-6 Use sine bar or sine plate for machine operations	B-7 Calculate for direct, simple, and angular indexing	B-8 Calculate speeds and feeds for machining	B-9 Calculate draft angle dimensions	B-10 Apply "shrink rate" formulas			
C Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Identify lines and symbols (GD&T)	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify require-ments	C-9 Analyze bill of materials (BOM)	C-10 Under-stand and use quality systems			
D Select Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Identify heat treating processes	D-3 Perform heat treating operations	D-4 Test metal samples for hardness	D-5 Evaluate alternative manufacturing processes								
E Perform Measurement/ Inspection	E-1 Identify types of measure-ment	E-2 Select proper measurement tools	E-3 Apply proper measuring techniques	E-4 Measure with hand held instruments	E-5 Measure/ layout/inspect using surface plate	E-6 Inspect using stationary equipment							
F Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/abrasive machines	F-9 Operate jig boring machines	F-10 Operate deburring equipment	F-11 Polish mold/die cavities	F-12 Operate tool and cutter grinders	
G Perform Advanced Machining Processes	G-1 Program Computer Numerical Control (CNC) machines	G-2 Operate CNC machining centers and turning centers	G-3 Operate electrical discharge machines										
H Perform Welding Operations	H-1 Weld with Shielded Metal Arc Welding (SMAW) process	H-2 Weld/cut with oxyacety-lene	H-3 Weld with Gas Tungsten Arc Welding (GTAW) (Heliarc)	H-4 Weld with Gas Metal Arc Welding (GMAW)/(Mig) & Flux Core Arc Welding (FCAW)									
I Build/Modify/ Repair Tools	I-1 Interpret tool drawings	I-2 Build/modify/ repair drill jigs	I-3 Build/modify/ repair mill fixtures	I-4 Build/modify/ repair dies	I-5 Build/modify/ repair patterns/ templates								
J Use Computers	J-1 Use computer operating systems	J-2 Use various computer applications	J-3 Use computer inquiry systems										

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SKILLS AND KNOWLEDGE

Communication Skills
Use Measurement Tools
Use Inspection Devices
Mathematical Skills
Reading/Writing Skills
Knowledge of Safety Regulations
Practice Safety in the Workplace
Organizational Skills
Knowledge of Company Policies/Procedures
Mechanical Aptitude
Ability to Comprehend Written/Verbal Instructions
Knowledge of Cutting Fluids/Lubricants
Basic Knowledge of Fasteners
Ability to Work as Part of a Team
Converse in the Technical Language of the Trade
Knowledge of Occupational Opportunities
Knowledge of Employee/Employer Responsibilities
Knowledge of Company Quality Assurance Activities
Practice Quality-Consciousness in Performance of the Job

SPRINGFIELD TECHNICAL COMMUNITY COLLEGE
MAST PROGRAM REPRESENTATIVES

DR. THOMAS E. HOLLAND
Director, Center for Business & Technology

GARY J. MASCIADRELLI
Department Chairman
Mechanical Engineering Technology

NICK M. MASSA
Director of Technology Development

ROSE MARY TIMMONS
Senior Secretary/Statistician (TSTC)

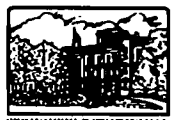
Furnished By:

SMITH & WESSON

RICHARD MARLOW
Superintendent of Services

BOB PION
Director, Human Resources Development

RONALD P. BORGIO
Director TQM/ISO Audit



TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators, magnetic tool holders, etc.)
Measuring Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Power Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment (SMAW, GMAW, FCAW)
CNC Machining Center and Turning Center
Gear Producing Machines with Attachments
Alignment/Calibration Tools
Coolant Recovery Equipment
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Weld Test Equipment
Optical Comparator
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Statistical Process Control
Composites
Laser Machining
Advanced Computer Applications
Robotics
Environmental Concerns
Fiber Optic Controls
Automated Material Handling Equipment
Computer Integrated Manufacturing

COMPETENCY PROFILE

Tool & Die Maker

Prepared By
M.A.S.T.
Machine Tool Advanced Skills
Technology Program
and
Consortia Partners
(V.199J40008)

TOOL & DIE MAKER.... **analyze variety of specifications, lay out metal stock, set up and operate machine tools, and fit and assemble parts to make and repair dies, cutting tools, jigs, fixtures, gages, and machinist's hand tools.**

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Follow safe operating procedures for hand and machine tools	A-4 Maintain a clean and safe work environment									
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Locate machining points from a datum point	B-3 Inter-convert fractions/ decimals	B-4 Inter-convert Metric/ English measurements	B-5 Perform basic trigonometric functions	B-6 Use sine bar or sine plate for machine operations	B-7 Calculate for direct, simple, and angular indexing	B-8 Calculate speeds and feeds for machining	B-9 Calculate draft angle dimensions	B-10 Apply "shrink rate" formulas			
C Interpret Engineering Drawings and Control Documents	C-1 Review blueprint notes and dimensions	C-2 Identify basic layout of drawings	C-3 Identify basic types of drawings	C-4 List the purpose of each type of drawing	C-5 Verify drawing elements	C-6 Identify lines and symbols (GD&T)	C-7 Describe the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 Understand and use quality systems	C-11 Create technical sketches		
D Select Manufacturing Materials and Processes	D-1 Identify materials with desired properties	D-2 Identify heat treating processes	D-3 Test metal samples for hardness	D-4 Evaluate alternative manufacturing processes	D-5 Identify types of plastic materials								
E Perform Measurement and Inspection	E-1 Study basics of metrology	E-2 Select instruments used for measurement	E-3 Interpret limits and tolerances	E-4 Select gagging tools	E-5 Use CMM for location of features	E-6 Perform surface metrology	E-7 Perform measurement by comparison	E-8 Perform circularity, cylindricity, profile of a line, and runout measurements	E-9 Investigate advanced metrology topics				
F Perform Conventional Machining Operations	F-1 Prepare and plan for machining operations	F-2 Use proper hand tools	F-3 Operate power saws	F-4 Operate drill presses	F-5 Operate vertical milling machines	F-6 Operate horizontal milling machines	F-7 Operate metal cutting lathes	F-8 Operate grinding/ abrasive machines	F-9 Operate jig boring machines	F-10 Operate deburring equipment	F-11 Polish mold/die cavities		
G Perform Advanced Machining Processes	G-1 Program Computer Numerical Control (CNC) machines	G-2 Operate CNC machining centers and turning centers	G-3 Operate electrical discharge machines										
H Build/Modify/ Repair Tools	H-1 Interpret tool drawings	H-2 Build/ modify/repair drill jigs	H-3 Build/ modify/repair mill fixtures	H-4 Build/ modify/repair dies	H-5 Build/ modify/repair molds	H-6 Build/ modify/repair patterns/ templates							
I Use Computers	I-1 Use various computer applications	I-2 Use computer inquiry systems											

SKILLS AND KNOWLEDGE
Communication Skills
Technical Reading/Writing Skills
Ability to Comprehend Written/Verbal Instructions
Leadership Skills
Organizational Skills
Knowledge of Company Policies/Procedures
Knowledge of Employee/Employer Responsibilities
Ability to Work as Part of a Team
Knowledge of Company Quality Assurance Activities
Knowledge of Safety Regulations/Responsibilities
Project/Task Management Skills
Logical/Systematic Problem Solving Skills
Computer Skills
Numerical/Mathematical Skills
Use Measurement Tools
Use Inspection Devices
Drafting Skills
Knowledge of Industrial Materials
Knowledge of Manufacturing Processes
Mechanical Aptitude

ITAWAMBA COMMUNITY COLLEGE MAST PROGRAM REPRESENTATIVES

Dr. Charles Chrestman
Dean/Director

Don Benjamin
Associate Dean/Site Administrator

Barry Emison
Site Coordinator

SUPER SAGLESS CORP. REPRESENTATIVES

Hoyt Hubbard
General Supervisor - Tooling Dept.

Rod Sheffield
Supervisor - Tool & Die Dept.

TRAITS AND ATTITUDES
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Personal Ethics
Innovative

TOOLS AND EQUIPMENT
Machinist's Tools (e.g., calipers, dial indicators
magnetic tool holders, etc.)
Measuring Tools
Metal Layout Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Band Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment
CNC Machining Center and Turning Center
Jig Boring Machines
Alignment/Calibration Tools
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS
Composites
In-Process Gauging
Rapid Tool Changing
Expanded Communication with Shop Floor
Multi-Axis Equipment
Computer-Integrated Manufacturing
Adaptive Controls
Conversational Programming
Artificial Intelligence

COMPETENCY PROFILE

Tool & Die Maker

Prepared By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortia Partners
(V.199J40008)

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machines and produce a variety of products

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Maintain a clean and safe work environment	A-4 Ensure safe operation of machines	A-5 Use safe machining practices	A-6 Use safe lifting practices	A-7 Use safe operating procedures for hand and machine tools	A-8 Consult and apply MSDS for hazards of various materials	A-9 Practice proper tag-out/ lock-out procedures	A-10 Practice electrical safety procedures			
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Inter-convert fractions/ decimals	B-3 Inter-convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Use basic geometric principles	B-7 Calculate and apply formulas	B-8 Use and apply basic concepts of technical physics					
C Demonstrate Quality Control and Management	C-1 Utilize appropriate inspection techniques	C-2 Perform appropriate use and calibration of inspection equipment	C-3 Know qualitative parameters of machinery and equipment	C-4 Know operation of coordinate measuring machine	C-5 Maintain equipment to produce quality parts	C-6 Know and use SPC techniques and concepts	C-7 Write inspection procedures	C-8 Document inspection results					
D Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Know machinability/ workability of various materials	D-3 Apply concepts of and calculate statics and stresses	D-4 Know/Find hardness characteristics/ chemistry of various material	D-5 Demonstrate knowledge of heat treating procedures and properties	D-6 Demonstrate knowledge of carbon index	D-7 Know stress relieving procedures	D-8 Determine, interpret, and evaluate availability of materials					
E Demonstrate Knowledge of Manufacturing Processes	E-1 Know operation of vertical and horizontal mills and tooling	E-2 Know operation of engine and turret lathes and tooling	E-3 Know operation of drill presses and tooling	E-4 Know operation of surface and cylindrical grinders	E-5 Know operation of heat treating equipment	E-6 Know operation of welding equipment	E-7 Know operation of gas cutting equipment	E-8 Know operation of punch / brake presses and tooling	E-9 Know operation of plate shears	E-10 Know operation of jig-boring machines and tooling	E-11 Know operation of tool and cutter grinders	E-12 Know operation of band and radial arm saws	E-13 Estimate time required/ cost to produce a part
	E-14 Know proper flow of parts through shop	E-15 Have knowledge of CNC programming language	E-16 Calculate tonnages required for press operations	E-17 Calculate bend allowances / use yield tables for sheet metal operations	E-18 Apply conservation of material concepts	E-19 Calculate speeds and feeds based on materials and tooling	E-20 Utilize concepts and principles of fixturing	E-21 Make calculations for sine bar/plate	E-22 Estimate capacity of equipment or manpower	E-23 Make calculations for rotary table and dividing head	E-24 Know operation of wire EDM	E-25 Know basic concepts of industrial painting/ plating	E-26 Schedule preventive maintenance for tooling and/or machine
F Perform CNC Programming/ CAM Tasks	F-1 Prepare and plan for CNC machining operations	F-2 Select, use, and acquire tooling systems for CNC machines	F-3 Manually program CNC machines	F-4 Set and use tooling offsets at CNC machine	F-5 Use Computer-Aided-Manufacturing (CAM) system	F-6 Transfer files from CAM system to machine	F-7 Interconvert CAD and CAM files using DXF or IGES formats	F-8 Install and maintain file transfer systems	F-9 Configure CAM system parameters				
G Perform Measurement/ Inspection	G-1 Know operation of O.D., I.D., and depth micrometers	G-2 Know operation of vernier, dial, & digital calipers	G-3 Read and use scale and tape measure	G-4 Know operation of dial-bore indicators	G-5 Know operation of dial indicators	G-6 Use precision square, center head, and protractor	G-7 Use digital read-out	G-8 Use finish/ profile gauges	G-9 Know operation of Rockwell hardness tester				
H Demonstrate Communication Skills	H-1 Read, interpret, and apply memorandums, letters, and written instructions	H-2 Read, interpret, and apply technical reports, procedures and manuals	H-3 Communicate technical information verbally	H-4 Read, interpret, and apply graphs, charts, and other visual aids	H-5 Write technical reports, procedures, and guidelines	H-6 Write memorandums, letters, or instructions							
I Perform Drafting/CAD Tasks	I-1 Demonstrate traditional mechanical drafting skills	I-2 Use Computer-Aided Drafting (CAD) system	I-3 Create 3-D solid models	I-4 Use and apply GD&T methodology	I-5 Generate and/or apply industry or company standards	I-6 Interconvert CAD and DXF or IGES formats	I-7 Configure CAD system parameters						

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Duties	Tasks												
J — Use Computers	J-1 Use computer operating systems	J-2 Use file management systems	J-3 Perform backup on a personal computer	J-4 Install/use software packages	J-5 Use computer network system	J-6 Use file transfer systems	J-7 Understand and apply computer terminology	J-8 Have working knowledge of hardware components	J-9 Understand RS-232 protocol				
K — Participate in Product Design Activities	K-1 Design parts for manufacturability	K-2 Design parts for functionality	K-3 Design parts for marketability	K-4 Plan and design for "mating of parts"	K-5 Be cost conscious with design of parts	K-6 Incorporate safety into product design	K-7 Determine, interpret, and evaluate customer specifications	K-8 Design, document, and validate testing methods	K-9 Coordinate production of prototype				
L — Interpret/Use Blueprints and Related Documents	L-1 Interpret, review, and apply blueprint notes, dimensions, and tolerances	L-2 Interpret and understand basic layout/ types of drawings	L-3 Understand and analyze bill of materials	L-4 Ascertain job requirements from drawings	L-5 Interpret and apply geometric dimensioning and tolerancing	L-6 Interpret and apply electrical schematic diagrams	L-7 Interpret and apply hydraulic or pneumatic diagrams	L-8 Interpret and apply plant layout drawings	L-9 Interpret and apply digital/ladder logic diagrams				
M — Manage Projects/Tasks	M-1 Compile and collate information	M-2 Conduct multiple project management	M-3 Set and maintain timelines	M-4 Prioritize tasks/duties/ projects	M-5 Preplan project activities	M-6 Demonstrate time/resource management	M-7 Perform research	M-8 Comprehend entire scope of project	M-9 Assess and evaluate / Revise or modify project layout				
N — Perform Die Operations	N-1 Utilize basic die theory	N-2 Visually inspect die components for damage	N-3 Disassemble and assemble die set	N-4 Determine proper cutting, clearance, and slug relief	N-5 Calculate proper shut-height of die set	N-6 Design stock strip layout	N-7 Determine press tonnage requirements	N-8 Calculate stripping pressures					

SKILLS AND KNOWLEDGE

Communication Skills
Technical Reading/Writing Skills
Ability to Comprehend Written/Verbal Instructions
Leadership Skills
Organizational Skills
Knowledge of Company Policies/Procedures
Knowledge of Employee/Employer Responsibilities
Ability to Work as Part of a Team
Knowledge of Company Quality Assurance Activities
Knowledge of Safety Regulations/Responsibilities
Project/Task Management Skills
Logical/Systematic Problem Solving Skills
Computer Skills
Numerical/Mathematical Skills
Use Measurement Tools
Use Inspection Devices
Drafting Skills
Knowledge of Industrial Materials
Knowledge of Manufacturing Processes
Mechanical Aptitude

ITAWAMBA COMMUNITY COLLEGE MAST PROGRAM REPRESENTATIVES

Dr. Charles Chrestman
Dean/Director

Don Benjamin
Associate Dean/Site Administrator

Barry Emison
Site Coordinator

TECUMSEH PRODUCTS REPRESENTATIVE

Wayne Brown
Maintenance Machinist

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Personal Ethics
Innovative

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators
magnetic tool holders, etc.)
Measuring Tools
Metal Layout Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Band Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment
CNC Machining Center and Turning Center
Jig Boring Machines
Alignment/Calibration Tools
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Composites
In-Process Gauging
Rapid Tool Changing
Expanded Communication with Shop Floor
Multi-Axis Equipment
Computer-Integrated Manufacturing
Adaptive Controls
Conversational Programming
Artificial Intelligence

COMPETENCY PROFILE

Tool & Die Maker

Prepared By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortia Partners
(V.199J40008)

TECUMSEH PRODUCTS

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machines and produce a variety of products

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Maintain a clean and safe work environment	A-4 Ensure safe operation of machines	A-5 Use safe machining practices	A-6 Use safe lifting practices	A-7 Use safe operating procedures for hand and machine tools						
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Inter-convert fractions/ decimals	B-3 Inter-convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Use basic geometric principles	B-7 Calculate and apply formulas	B-8 Use and apply basic concepts of technical physics					
C Demonstrate Quality Control and Management	C-1 Utilize appropriate inspection techniques	C-2 Perform appropriate use and calibration of inspection equipment	C-3 Know qualitative parameters of machinery and equipment	C-5 Maintain equipment to produce quality parts									
D Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Know machinability/ workability of various materials	D-3 Apply concepts of and calculate statics and stresses	D-4 Know/Find hardness characteristics/ chemistry of various material	D-5 Demonstrate knowledge of heat treating procedures and properties	D-6 Demonstrate knowledge of carbon index	D-7 Know stress relieving procedures	D-8 Determine, interpret, and evaluate availability of materials					
E Demonstrate Knowledge of Manufacturing Processes	E-1 Know operation of vertical and horizontal mills and tooling	E-2 Know operation of engine and turret lathes and tooling	E-3 Know operation of drill presses and tooling	E-4 Know operation of surface and cylindrical grinders	E-5 Know operation of heat treating equipment	E-6 Know operation of welding equipment	E-7 Know operation of gas cutting equipment	E-8 Know operation of punch / brake presses and tooling	E-9 Know operation of plate shears	E-10 Know operation of jig-boring machines and tooling	E-11 Know operation of tool and cutter grinders	E-12 Know operation of band and radial arm saws	E-13 Estimate time required/ cost to produce a part
	E-14 Know proper flow of parts through shop	E-15 Have knowledge of CNC programming language	E-16 Calculate tonnages required for press operations	E-17 Calculate bend allowances / use yield tables for sheet metal operations	E-18 Apply conservation of material concepts	E-19 Calculate speeds and feeds based on materials and tooling	E-20 Utilize concepts and principles of fixturing	E-21 Make calculations for sine bar/plate	E-22 Estimate capacity of equipment or manpower	E-23 Make calculations for rotary table and dividing head	E-24 Know operation of wire EDM	E-25 Know basic concepts of industrial painting/ plating	E-26 Schedule preventive maintenance for tooling and/or machine
F Perform CNC Programming/ CAM Tasks	F-1 Prepare and plan for CNC machining operations	F-2 Select, use, and acquire tooling systems for CNC machines	F-3 Manually program CNC machines	F-4 Set and use tooling offsets at CNC machine									
G Perform Measurement/ Inspection	G-1 Know operation of O.D., I.D., and depth micrometers	G-2 Know operation of vernier, dial, & digital calipers	G-3 Read and use scale and tape measure	G-4 Know operation of dial-bore indicators	G-5 Know operation of dial indicators	G-6 Use precision square, center head, and protractor	G-7 Use digital read-out	G-8 Use finish/ profile gauges	G-9 Know operation of Rockwell hardness tester				
H Demonstrate Communication Skills	H-1 Read, interpret, and apply memorandums, letters, and written instructions	H-2 Read, interpret, and apply technical reports, procedures and manuals	H-3 Communicate technical information verbally	H-4 Read, interpret, and apply graphs, charts, and other visual aids	H-5 Write technical reports, procedures, and guidelines	H-6 Write memorandums, letters, or instructions							
I Perform Drafting/CAD Tasks	I-1 Demonstrate traditional mechanical drafting skills	I-2 Use Computer-Aided Drafting (CAD) system	I-4 Use and apply GD&T methodology										

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Duties	Tasks												
J Use Computers	J-1 Use computer operating systems	J-2 Use file management systems	J-3 Perform backup on a personal computer	J-4 Install/use software packages	J-7 Understand and apply computer terminology				J-9 Understand RS-232 protocol				
K Perform Die Operations	K-1 Utilize basic die theory	K-2 Visually inspect die components for damage	K-3 Disassemble and assemble die set	K-4 Determine proper cutting, clearance, and slug relief	K-5 Calculate proper shut-height of die set	K-6 Design stock strip layout	K-7 Determine press tonnage requirements	K-8 Calculate stripping pressures					
L Interpret/Use Blueprints and Related Documents	L-1 Interpret, review, and apply blueprint notes, dimensions, and tolerances	L-2 Interpret and understand basic layout/ types of drawings	L-3 Understand and analyze bill of materials	L-4 Ascertain job requirements from drawings	L-5 Interpret and apply geometric dimensioning and tolerancing	L-6 Interpret and apply electrical schematic diagrams	L-7 Interpret and apply hydraulic or pneumatic diagrams	L-8 Interpret and apply plant layout drawings	L-9 Interpret and apply digital/ladder logic diagrams				
M Manage Projects/Tasks	M-1 Compile and collate information	M-2 Conduct multiple project management	M-3 Set and maintain timelines	M-4 Prioritize tasks/duties/ projects	M-5 Preplan project activities	M-6 Demonstrate time/resource management	M-7 Perform research	M-8 Comprehend entire scope of project	M-9 Assess and evaluate / Revise or modify project layout				

SKILLS AND KNOWLEDGE

Communication Skills
Technical Reading/Writing Skills
Ability to Comprehend Written/Verbal Instructions
Leadership Skills
Organizational Skills
Knowledge of Company Policies/Procedures
Knowledge of Employee/Employer Responsibilities
Ability to Work as Part of a Team
Knowledge of Company Quality Assurance Activities
Knowledge of Safety Regulations/Responsibilities
Project/Task Management Skills
Logical/Systematic Problem Solving Skills
Computer Skills
Numerical/Mathematical Skills
Use Measurement Tools
Use Inspection Devices
Drafting Skills
Knowledge of Industrial Materials
Knowledge of Manufacturing Processes
Mechanical Aptitude

ITAWAMBA COMMUNITY COLLEGE MAST PROGRAM REPRESENTATIVES

Dr. Charles Chrestman
Dean/Director

Don Benjamin
Associate Dean/Site Administrator

Barry Emison
Site Coordinator

THOMAS LIGHTING REPRESENTATIVES

Billy Coleman
Tool & Die Maker

Gary Cox
Tool & Die Manager

Clarence Hoing
Tool & Die Supervisor

Terry Self
Tool & Die Maker

Jerry Underwood
Tool Room Foreman

TRAITS AND ATTITUDES

Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Personal Ethics
Innovative

TOOLS AND EQUIPMENT

Machinist's Tools (e.g., calipers, dial indicators
magnetic tool holders, etc.)
Measuring Tools
Metal Layout Tools
Power Tools
Metal Lathe with Attachments
Drill Presses
Vertical Mill with Attachments
Band Saws
Power Drills
Hydraulic/Arbor Press
Heat Treatment Equipment
Hardness Testing Equipment
Grinding Machines with Attachments
Welding Equipment
CNC Machining Center and Turning Center
Jig Boring Machines
Alignment/Calibration Tools
Computer
Ventilation Equipment
Forklift
Personal Safety Equipment
Oxyacetylene Equipment
Tool Storage Equipment
Workbenches
Vises
Pedestal Grinders
Coordinate Measurement Machine

FUTURE TRENDS AND CONCERNS

Composites
In-Process Gauging
Rapid Tool Changing
Expanded Communication with Shop Floor
Multi-Axis Equipment
Computer-Integrated Manufacturing
Adaptive Controls
Conversational Programming
Artificial Intelligence

COMPETENCY PROFILE

Tool & Die Maker

Prepared By
M.A.S.T.
Machine Tool Advanced Skills Technology Program
and
Consortia Partners
(V.199J40008)

THOMAS®
LIGHTING

TOOL AND DIE MAKER .... skilled workers who produce tools, dies, and special guiding and holding devices that are used in machines and produce a variety of products

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Maintain safe equipment and machinery	A-3 Maintain a clean and safe work environment	A-4 Ensure safe operation of machines	A-5 Use safe machining practices	A-6 Use safe lifting practices	A-7 Use safe operating procedures for hand and machine tools	A-8 Consult and apply MSDS for hazards of various materials	A-9 Practice proper tag-out/ lock-out procedures	A-10 Practice electrical safety procedures			
B Apply Mathematical Concepts	B-1 Perform basic arithmetic functions	B-2 Inter-convert fractions/ decimals	B-3 Inter-convert Metric/ English measurements	B-4 Perform basic algebraic operations	B-5 Perform basic trigonometric functions	B-6 Use basic geometric principles	B-7 Calculate and apply formulas	B-8 Use and apply basic concepts of technical physics	B-9 Use and apply cartesian coordinate system				
C Demonstrate Quality Control and Management	C-1 Utilize appropriate inspection techniques	C-2 Perform appropriate use and calibration of inspection equipment	C-3 Know qualitative parameters of machinery and equipment	C-4 Know operation of coordinate measuring machine	C-5 Maintain equipment to produce quality parts	C-6 Know and use SPC techniques and concepts	C-7 Know and use ISO 9000 concepts and procedures	C-8 Document inspection results	C-9 Write inspection procedures				
D Demonstrate Knowledge of Manufacturing Materials	D-1 Identify materials with desired properties	D-2 Know machinability/ workability of various materials	D-3 Apply concepts of and calculate statics and stresses	D-4 Know/Find hardness characteristics/ chemistry of various material	D-5 Demonstrate knowledge of heat treating procedures and properties	D-6 Demonstrate knowledge of carbon index	D-7 Know stress relieving procedures	D-8 Determine, interpret, and evaluate availability of materials					
E Demonstrate Knowledge of Manufacturing Processes	E-1 Know operation of vertical and horizontal mills and tooling	E-2 Know operation of engine and turret lathes and tooling	E-3 Know operation of drill presses and tooling	E-4 Know operation of surface and cylindrical grinders	E-5 Know operation of heat treating equipment/processes	E-6 Know operation of welding equipment	E-7 Know operation of gas cutting equipment	E-8 Know operation of punch / brake presses and tooling	E-9 Know operation of plate shears	E-10 Know operation of jig-boring machines and tooling	E-11 Know operation of tool and cutter grinders	E-12 Know operation of band and radial arm saws	E-13 Know operation of wire EDM
	E-14 Know proper flow of parts through shop	E-15 Have knowledge of CNC programming language	E-16 Calculate tonnages required for press operations	E-17 Calculate bend allowances / use yield tables for sheet metal operations	E-18 Apply conservation of material concepts	E-19 Calculate speeds and feeds based on materials and tooling	E-20 Utilize concepts and principles of fixturing	E-21 Make calculations for sine bar/plate	E-22 Estimate time required and/or cost to produce a part	E-23 Make calculations for rotary table and dividing head	E-24 Schedule preventive maintenance for tooling and/or machine	E-25 Know basic concepts of industrial painting/ plating	
F Perform CNC Programming/ CAM Tasks	F-1 Prepare and plan for CNC machining operations	F-2 Select, use, and acquire tooling systems for CNC machines	F-3 Manually program CNC machines	F-4 Set and use tooling offsets at CNC machine	F-5 Use Computer-Aided-Manufacturing (CAM) system	F-6 Transfer files from CAM system to machine	F-7 Interconvert CAD and CAM files using DXF or IGES formats	F-8 Install and maintain file transfer systems	F-9 Configure CAM system parameters				
G Perform Measurement/ Inspection	G-1 Know operation of O.D., I.D., and depth micrometers	G-2 Know operation of vernier, dial, & digital calipers	G-3 Read and use scale and tape measure	G-4 Know operation of dial-bore indicators	G-5 Know operation of dial indicators	G-6 Use precision square, center head, and protractor	G-7 Use digital read-out	G-8 Use finish/ profile gauges	G-9 Know operation of Rockwell hardness tester	G-10 Know operation of oscilloscope	G-11 Know operation of multimeter	G-12 Know operation of meg-ohm meter (megger)	
H Demonstrate Communication Skills	H-1 Read, interpret, and apply memorandums, letters, and written instructions	H-2 Read, interpret, and apply technical reports, procedures and manuals	H-3 Communicate technical information verbally	H-4 Read, interpret, and apply graphs, charts, and other visual aids	H-5 Write technical reports, procedures, and guidelines	H-6 Write memorandums, letters, or instructions							
I Perform Drafting/CAD Tasks	I-1 Demonstrate traditional mechanical drafting skills	I-2 Use Computer-Aided Drafting (CAD) system	I-3 Create 3-D solid models	I-4 Use and apply GD&T methodology	I-5 Generate and/or apply industry or company standards	I-6 Interconvert CAD and DXF or IGES formats	I-7 Configure CAD system parameters						

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Duties	Tasks												
J — Use Computers	J-1 Use computer operating systems	J-2 Use file management systems	J-3 Perform backup on a personal computer	J-4 Install/use software packages	J-5 Use computer network system	J-6 Use file transfer systems	J-7 Understand and apply computer terminology	J-8 Have working knowledge of hardware components	J-9 Understand RS-232 protocol				
K — Participate in Product Design Activities	K-1 Design parts for manufacturability	K-2 Design parts for functionality	K-3 Design parts for marketability	K-4 Plan and design for "mating of parts"	K-5 Be cost conscious with design of parts	K-6 Incorporate safety into product design	K-7 Determine, interpret, and evaluate customer specifications	K-8 Design, document, and validate testing methods	K-9 Coordinate production of prototype				
L — Interpret/Use Blueprints and Related Documents	L-1 Interpret, review, and apply blueprint notes, dimensions, and tolerances	L-2 Interpret and understand basic layout/ types of drawings	L-3 Understand and analyze bill of materials	L-4 Ascertain job requirements from drawings	L-5 Interpret and apply geometric dimensioning and tolerancing	L-6 Interpret and apply electrical schematic diagrams	L-7 Interpret and apply hydraulic or pneumatic diagrams	L-8 Interpret and apply plant layout drawings	L-9 Interpret and apply digital logic diagrams				
M — Manage Projects/Tasks	M-1 Compile and collate information	M-2 Conduct multiple project management	M-3 Set and maintain timelines	M-4 Prioritize tasks/duties/ projects	M-5 Preplan project activities	M-6 Demonstrate time/resource management	M-7 Perform research	M-8 Comprehend entire scope of project	M-9 Assess and evaluate / Revise or modify project methodology				
N — Perform Die Operations	N-1 Utilize basic die theory	N-2 Visually inspect die components for damage	N-3 Disassemble and assemble die set	N-4 Determine proper cutting, clearance, and slug relief	N-5 Calculate proper shut-height of die set	N-6 Design stock strip layout	N-7 Determine press tonnage requirements	N-8 Calculate stripping pressures					

APPENDIX B - PILOT PROGRAM NARRATIVE

What follows is a narrative of the pilot program which was conducted for this particular occupational specialty.

MAST STUDENT PILOT PROGRAM
DESCRIPTION / NARRATIVE

Located in the industrialized northeast section of Mississippi, Itawamba Community College's Tupelo campus is a primary training facility for traditional and non-traditional students desiring employment in the industrial sector by making quality training accessible and affordable to the general population. Having worked closely with local manufacturing and industrial partners, the college has maintained an open training policy with the flexibility to meet local manpower needs. Many graduates transfer and successfully complete higher degrees at four year institutions while others enter successful careers in manufacturing and industry.

During the fall semester, 1995, and spring semester, 1996, Itawamba Community College participated in the MAST Pilot Program for Tool and Die Making Technology. Instructors trained students to the technical workplace competencies defined by MAST and industrial partners in the project using curriculum currently endorsed by the Mississippi State Department of Education.

Members of the pilot group included all freshmen entering the Tool and Die Making Technology program on the Tupelo campus. The normal student population for the college is mirrored in the pilot group with the majority being traditional, full time students. Special populations represented include veterans, single parents, socioeconomically depressed, and non-traditional occupational fields.

As most students attending Itawamba Community College on a full time basis do secure some form of outside financial assistance, all pilot program participants have followed standard entrance procedures of the college which included the opportunity for making application to various available funding sources for aid. Nearly 85% of the participants financed their training through a combination of grants, scholarships, loans, and part time work: two grants were awarded; five loans have been secured; eight scholarships were given; and one position through the Work-Study Program was filled. One participant received the 1995-1996 Luther Garrett-Joe Lewis Memorial Scholarship, a statewide honor given annually to one outstanding high school student to be enrolled at the community college level. Instructors have worked closely with financially depressed students in helping them secure part time work in the private sector. Of pilot project participants, 38% are currently employed in out-of-school, field-related positions.

To determine the program's effectiveness, the students were assessed at the beginning of the Fall semester using criteria contained in the Student Examination. A copy of this form is provided and a brief description given below. As indicated, the students will be evaluated again near the end of the Spring semester to assess the progress made in the first year of the program. As Tool and Die Technology is a two-year Associate Degree program, participants will not have received full benefits of instruction by the end of this period. The students, however, will be evaluated upon completion of training to insure mastery of all competencies as defined by MAST and industrial partners. Intentions are to track these individuals into the workforce and determine their actual readiness and performance against the employers' expectations.

MAST Pilot Program ---- Student Assessment
Analysis of Results

1. **MAST Consortia Partner College:**
Itawamba Community College at Tupelo, Mississippi

2. **Number and category of those enrolled in the program:**

Started	Finished	
13	13	100 % Completion Rate
12	12	Male
1	1	Female
12	12	White
1	1	Black
0	0	Hispanic
0	0	Asian
0	0	Native American
0	0	Foreign

* Please note that in the following section that some students fall into more than one category.

0	0	Single Head of Household
2	2	Single Parent
0	0	Disability (Physical or Mental)
2	2	Social / Economic Status (gross family income of $22,800 or less)
1	1	Non-traditional Occupational Fields (females in all high technology areas, and all minorities in all high technology fields except welding and conventional machining)
12	12	Traditional Students

3. **Entrance and exit examination description:**

All students were evaluated on their individual abilities to meet the minimum standards for technical workplace competencies of a Tool and Die Maker. These evaluations were conducted by the Tool and Die Technology instructors at the college after given sufficient time to observe the students during the first weeks of their first semester. The student's grade reflects a subjective evaluation of his/her ability to perform the required duties and tasks of a Tool and Die Maker. Emphasis was placed on the students' classroom

participation, shop demeanor, test performance, and overall ability to comprehend the material presented. This evaluation will be conducted again near the end of the second semester and will be compared to the first to determine the effectiveness of the program. At the time this was written, the exit examination had not been conducted since the program is only partially completed. A copy of the evaluation form, showing each competency and the rating scale, is provided.

4. **Pilot Test Results:**

Entry	Exit	Category
7	48	Single Parent
22	63	Social / Economic Status (gross family income of $22,800 or less)
5	44	Non-traditional Occupational Fields (females in all high technology areas, and all minorities in all high technology fields except welding and conventional machining)
19	60	Traditional Students

* Values shown are the average score for each category and reflect ratio between current proficiency level and expected exit proficiency level (after 2 years in program)

TECHNICAL WORKPLACE COMPETENCIES FOR TOOL & DIE MAKER

STUDENT EXAMINATION

Name: _____ **Date:** _____

Instructor: _____

Directions: Select the appropriate rating for this student on each competency listed below.

Rating Scale:

1 No or very little knowledge in area; requires constant supervision
2 Limited knowledge in area; requires close supervision
3 Average knowledge in area; requires regular supervision
4 Above average knowledge in area; requires minimum supervision
5 Mastery of knowledge in area; able to comprehend and apply without supervision

A. PRACTICE SAFETY:	RATING SCALE				
1 Follow safety manuals and all safety regulations/requirements:	**1**	**2**	**3**	**4**	**5**
a. Comply with established company and OSHA regulations					
b. Interpret safety manual directives					
c. Wear safety / protective equipment as required					
2 Maintain safe equipment and machinery:					
a. Maintain equipment/tooling in safe operation condition					
b. Maintain all guards, shields, and barriers in place and in good condition					
c. Perform preventive maintenance as required					
d. Practice proper tag-out/lock-out procedures					
3 Maintain a clean and safe work environment:					
a. Keep work areas clean and free of debris					
b. Keep isles / traffic areas clear of equipment and materials					
c. Store materials, tools, and instruments in organized manner					
d. Clean machine / hand tools when work is complete					
4 Use safe operating procedures for hand and machine tools					
a. Use tools for intended purposes only					
b. Acquire proper training / authorization before operating equipment					
c. Operate hand and machine tools in safe manner					
d. Comply with manufacturer's rated capacity for equipment					
e. Ensure all rotating or moving parts have stopped before leaving area					
f. Inspect for and remove possible hazards before engaging equipment					

NAME:

INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
	5 Use safe machining practices	1	2	3	4	5
a.	Ensure stock / tooling is secure before machining					
b.	Use chip control methods					
c.	Use moderate, safe, and calculated speeds and feeds					
d.	Stay alert and prepared to act during machining					
e.	Ensure rotating parts / tooling are completely stopped before handling					
	6 Use safe lifting practices					
a.	Use lifting aids when necessary					
b.	Use OSHA approved chains, straps, and hoists					
c.	Comply with rated capacity of lifting equipment					
d.	Comply with company / OSHA regulations regarding lifting procedures					
	7 Consult and apply MSDS for hazards of various materials					
a.	Know format of material safety data sheets					
b.	Consult and interpret MSDS to determine relevant hazards of material					
c.	Apply information and take precautionary measures against hazards					
d.	Notify proper authorities of hazards					
	B. APPLY MATHEMATICAL CONCEPTS					
	1 Perform basic arithmetic functions					
a.	Add, subtract, multiply, and divide whole numbers					
b.	Add, subtract, multiply, and divide fractions					
c.	Add, subtract, multiply, and divide decimals					
d.	Interconvert fractions / decimals					
e.	Interconvert Metric / English measurements					
	2 Perform basic algebraic operations					
a.	Evaluate equation using standard algebraic hierarchy					
b.	Solve equations with one unknown variable					
c.	Solve ratio / percentage problems					
d.	Calculate and apply formulas					
	3 Perform basic trigonometric functions					
a.	Solve for unknown sides/angles of right triangles usin trigonometric functions					
b.	Solve for unknown side of right triangle using Pythagorean's Theorem					

NAME:

INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
	4 Use basic geometric principles	1	2	3	4	5
a.	Solve for surface area, perimeter, and volume of cube					
b.	Solve for surface area, perimeter, and volume of rectangular solid					
c.	Solve for surface area, perimeter, and volume of right triangular solid					
d.	Solve for surface area, perimeter, and volume of cylinder					
e.	Find diagonal of a square					
	5 Use and apply Cartesian coordinate system					
a.	Define the Cartesian coordinate system					
b.	Calculate coordinates of bolt circle on Cartesian coordinate system					
c.	Plot machining points using Cartesian coordinate system					
C.	**DEMONSTRATE QUALITY CONTROL AND MANAGEMENT**					
	1 Utilize appropriate inspection techniques					
a.	Discuss factors that affect accurate measurement					
b.	Determine proper procedure to acquire accurate measurement					
c.	Determine proper instrument to use in measurement					
	2 Perform appropriate use and calibration of inspection equipment					
a.	Explain calibration requirements of various precision instruments					
b.	Maintain / care for instruments for optimum performance					
c.	Read and use O.D., I.D., and depth micrometers					
d.	Read and use vernier, dial, & digital calipers					
e.	Read and use scale and tape measure					
f.	Read and use dial-bore indicators					
g.	Use dial indicators					
h.	Use precision square and combination set					
i.	Read and use digital read-out					
j.	Use finish / profile gauges					
k.	Use Rockwell hardness tester					
l.	Know operation of coordinate measuring machine (CMM)					
m.	Use surface plates					

NAME:

INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
		1	2	3	4	5
3	**Know qualitative parameters of machinery and equipment**					
a.	Differentiate between types of machinery by qualitative capabilities					
b.	Select appropriate processes to maintain desired tolerances					
c.	Discuss the effect one process might have on an earlier or later process					
4	**Maintain equipment to produce quality parts**					
a.	Justify tooling by qualitative requirements					
b.	Protect / maintain critical surfaces of machines					
c.	Perform preventive maintenance on equipment					
5	**Know and use quality systems**					
a.	Know and use ISO 9000 concepts and procedures					
b.	Know and use Statistical Process Control (SPC) techniques and concepts					
6	**Write inspection procedures**					
a.	Determine / designate proper inspection technique					
b.	Determine / designate precautions to take during inspection					
c.	Determine / design inspection jig or fixture required					
d.	List in order and define steps required to ensure accurate measurement					
7	**Document inspection results**					
a.	Define procedure used during inspection					
b.	Accurately document measurements taken and compare to standard					
c.	Determine / document if part passes or fails inspection					
d.	Determine / document rework or scrap recommendations					
D	**DEMONSTRATE KNOWLEDGE OF MANUFACTURING MATERIALS**					
1	**Identify materials with desired properties**					
a.	Determine / identify service requirements (strength, hardness, etc.)					
b.	Determine, interpret, and evaluate availability of materials					
c.	Describe general characteristics of various metals					
d.	Know concepts of / calculate statics and stresses					
2	**Demonstrate knowledge of physical properties of materials**					
a.	Defines hardness					
b.	Defines toughness					

NAME: INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
	2 Demonstrate knowledge of physical properties of materials cont.	1	2	3	4	5
c.	Define tensile strength					
d.	Define shear strength					
e.	Define elasticity					
f.	Define ductility					
g.	Discuss the Rockwell and Brinell hardness scales					
h.	Discuss the Charpy / Izod impact tests					
	3 Identify manufacturing properties of materials					
a.	Discuss machinability of various materials					
b.	Discuss cold forming / workability of various materials					
c.	Define work hardening / edge hardening					
d.	Identify welding properties of various materials					
e.	Demonstrate knowledge of heat treating procedures and properties					
f.	Know stress relieving procedures					
g.	Know / Find hardness characteristics and chemistry of various materials					
	4 Discuss classification system for metals					
a.	Identify and discuss types of carbon steel					
b.	Determine chemistry of material by classification					
c.	Distinguish between SAE and AISI classification systems					
d.	Identify designation of each digit of steel classification					
e.	Discuss alloy steels					
	E. DEMONSTRATE KNOWLEDGE OF MANUFACTURING PROCESSES					
	1 Know operation of vertical and horizontal mills and tooling					
a.	Define milling machines, horizontal and vertical					
b.	List, describe, and give function and maintenance of different types of tooling used on milling machines					
c.	Set-up and operate horizontal and vertical milling machine					
d.	Explain machine components and accessories of milling machines					
e.	Explain milling processes					
f.	Discuss milling machine safety					
g.	Discuss CNC machining centers and processes					
h.	Calculate speeds and feeds based on materials and tooling					
i.	Set-up and operate CNC machining center					

NAME:

INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
		1	2	3	4	5
2	**Know operation of engine and turret lathes and tooling**					
a.	Define lathes, engine and turret					
b.	List, describe, and give function and maintenance of various types of tooling used on lathes					
c.	Set-up and operate engine and turret lathes					
d.	Explain machine components and accessories of lathes					
e.	Explain turning processes					
f.	Discuss lathe safety					
g.	Discuss CNC turning centers and processes					
h.	Calculate speeds and feeds based on materials and tooling					
i.	Set-up and operate CNC turning center					
3	**Know operation of drill presses and tooling**					
a.	Identify types of drilling machines					
b.	List, describe, and give function and maintenance of various types of tooling used on drilling machines					
c.	Set-up and operate drilling machines					
d.	Explain machine components and accessories of drilling machines					
e.	Explain processes performed on drilling machines					
f.	Discuss drilling safety					
g.	Discuss drilling operations on CNC drilling machines					
h.	Calculate speeds and feeds based on materials and tooling					
i.	Set-up and operate CNC drilling machine					
4	**Know operation of surface and cylindrical grinders**					
a.	Define grinders, surface and cylindrical					
b.	Explain types and maintenance of grinding wheels					
c.	Set-up and operate grinding machines					
d.	Explain machine components and accessories of grinding machines					
e.	Explain grinding processes					
f.	Discuss grinding safety					

NAME: INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
	5 Know operation of heat treating equipment and processes	1	2	3	4	5
a.	Describe types of heat treating equipment					
b.	Set-up and operate heat treating equipment					
c.	Explain machine components and accessories of heat treating equipment					
d.	Explain heat treating procedures					
e.	Discuss heat treating safety					
	6 Know operation of welding equipment and processes					
a.	Identify various types of welding equipment					
b.	Identify and discuss the difference in welding processes					
c.	Inspect welds for cracks and penetration					
d.	Discuss welding safety					
	7 Know sheet metal operations					
a.	Discuss gas / plasma cutting equipment and processes					
b.	Discuss operation of punch / brake presses and tooling					
c.	Discuss operation of plate shears					
d.	Calculate tonnages required for press / shear operations					
e.	Calculate blank dimensions of developed parts					
f.	Use yield tables for bending sheet metal					
g.	Discuss fabrication of sheet metal parts					
h.	Demonstrate layout-on-metal					
i.	Apply conservation-of-material concepts					
	8 Know operation of jog-boring machines and tooling					
a.	Define jig-boring machine					
b.	List, describe, and give function and maintenance of different typ of tooling used on jig-boring machines					
c.	Set-up and operate jig-boring machine					
d.	Explain machine components and accessories of jig-boring machines					
e.	Explain jig-boring process					
f.	Discuss safety on jig-boring machine					
g.	Calculate speeds and feeds based on materials and tooling					

NAME: INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

	RATING SCALE				
9 Know operation of tool and cutter grinders	1	2	3	4	5
a. Define tool / cutter grinder					
b. Discuss dressing and maintenance of grinding wheels					
c. Explain machine components and accessories of tool / cutter grinder					
d. Discuss tool and cutter grinder safety					
10 Know operation of metal saws					
a. Define band saw, horizontal and vertical					
b. Set-up and operate band saw					
c. Define abrasive cut-off saw					
d. Set-up and operate abrasive cut-off saw					
e. Discuss application of the different tooth forms, pitch sets, and gages of band saw blades					
f. Weld and maintain band saw blade					
g. Discuss band saw safety					
h. Calculate speeds and feeds based on materials and tooling					
i. Explain machine components and accessories of band saws					
j. Calculate proper length of band saw blade					
11 Know operation of wire EDM					
a. Define EDM					
b. Explain EDM process					
c. Set-up and operate CNC wire EDM					
d. Discuss EDM safety					
e. Calculate E-pac value for wire EDM					
f. Explain machine components and accessories of wire EDM					
12 Estimate time required/cost to produce a part					
a. Determine processes required to produce part					
b. Calculate actual machining and handling time					
c. Calculate material quantity and cost					
d. Calculate labor and overhead cost					

NAME: INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
		1	2	3	4	5
13	**Know proper flow of parts through shop**					
a.	Discuss proper order of processes					
b.	Discuss ergonomic aspects of plant layout					
14	**Utilize concepts and principles of fixturing**					
a.	Determine need for fixture / jig					
b.	Design appropriate fixture / jig					
c.	Identify components used in fixtures / jigs					
d.	Disassemble and assemble fixture / jig					
e.	Discuss relationship between accuracy of fixture & of repeatability of parts					
15	**Make calculations for and use sine bar/sine plate**					
a.	Define sine bar / sine plate					
b.	Calculate gage block buildup for sine bar / sine plate					
c.	Set-up and use sine bar / sine plate					
16	**Make calculations for and use rotary table and dividing head**					
a.	Set-up and use rotary table / dividing head for machining operations					
b.	Make calculations for number of rotations required					
c.	Determine / select appropriate index plate for dividing head					
F	**PERFORM CNC PROGRAMMING/CAM TASKS**					
1	**Prepare and plan for CNC machining operations**					
a.	Plan sequence of machining events					
b.	Determine proper tooling / fixtures required for machining					
c.	Calculate speeds, feeds, and depth-of-cut for machining					
d.	Explain the x, y, and z, axis on CNC machines					
2	**Select and use tooling systems for CNC machines**					
a.	Understand machinability and chip formation					
b.	Select proper insert materials and geometry					
c.	Select proper tooling system					
d.	Define and discuss application of HSS, carbide, and borazon cutting tools					
3	**Manually program CNC machines**					
a.	Plan and write programs for CNC machines					
b.	Use MDI panel on machine to program / edit programs					

NAME:

INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

	RATING SCALE				
3 Manually program CNC machines cont.	1	2	3	4	5
c. Set and use tooling offsets at CNC machine					
d. Discuss / use canned or bar cycles in program					
4 Use Computer-Aided-Manufacturing (CAM) system					
a. Create toolpath geometry using CAM system					
b. Interconvert CAD and CAM files using acceptable exchange format					
c. Transfer files from CAM system to machine					
d. Configure CAM system parameters					
G. DEMONSTRATE COMMUNICATION SKILLS					
1 Use written correspondence					
a. Read, write, interpret, and apply memorandums					
b. Read, write, interpret, and apply business letters					
c. Read, write, interpret, and apply written instructions					
2 Use written technical information					
a. Read, write, interpret, and apply technical reports					
b. Read, write, interpret, and apply written procedures					
c. Read, write, interpret, and apply technical manuals					
3 Communicate technical information verbally					
a. Demonstrate ability to listen to and understand verbal information / instructions					
b. Ask appropriate questions to ascertain needed information					
c. Demonstrate ability to give verbal technical information / instructions					
4 Use graphics for visual aid					
a. Create, read, and apply graphs					
b. Create, read, and apply charts					
c. Create, read, and apply graphical illustrations					
H. PERFORM DRAFTING/CAD TASKS					
1 Demonstrate traditional mechanical drafting skills					
a. Demonstrate use of drafting machine and instruments					
b. Demonstrate drafting technique to create basic geometric elements					

NAME: INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
1	**Demonstrate traditional mechanical drafting skills cont.**	**1**	**2**	**3**	**4**	**5**
c.	Demonstrate isometric sketching of objects					
d.	List and apply the three primary planes of projection					
e.	List and apply the six principle views.					
f.	Use and apply auxiliary views					
g.	Create sectional views					
2	**Use Computer-Aided-Drafting (CAD) system**					
a.	Create geometry using CAD system					
b.	Create 3-D solid models					
c.	Interconvert CAD and accepted drawing exchange formats					
d.	Configure CAD system parameters					
e.	Use peripheral devices					
3	**Use and apply geometric dimensioning and tolerancing (GD&T) methodology**					
a.	Distinguish between conventional and geometric dimensioning and tolerancing.					
b.	Explain and use geometric positional tolerancing					
c.	Explain and use tolerances of form					
d.	Explain and use the feature control symbol					
e.	Explain and use modifiers in geometric dimensioning and tolerancing					
I.	**USE COMPUTERS**					
1	**Use computer operating systems**					
a.	Explain the phrase "IBM compatible"					
b.	Use DOS operating system / DOS commands					
c.	Use Windows					
d.	Use computer network system					
2	**Use file management systems**					
a.	Discuss file management concepts					
b.	Create / remove directories					
c.	Copy files from floppy disks to hard drive					

NAME:

INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
	3 Perform backup on a personal computer	1	2	3	4	5
a.	Discuss need to backup hard disk					
b.	Perform complete backup of hard disk					
c.	Perform backup of selected files and directories					
d.	Restore backup set to hard disk					
e.	Discuss need for / make system disk					
	4 Install/use software packages					
a.	Install software package to hard disk					
b.	Configure system parameters for software package					
c.	Use word processor software (WordPerfect, MS Word)					
d.	Use spreadsheet software (Lotus, MS Excel)					
	5 Understand and apply computer terminology					
a.	Define Read Only Memory (ROM)					
b.	Define Random Access Memory (RAM)					
c.	Define cache memory					
d.	Define byte, kilobyte, megabyte					
e.	Define Central Processing Unit (CPU)					
f.	Discuss processor speed					
g.	Understand RS-232 protocol					
	J. INTERPRET/USE BLUEPRINTS AND RELATED DOCUMENTS					
	1 Interpret, review, and apply blueprint notes, dimensions, and tolerances					
a.	Distinguish between general and specific notes					
b.	Interpret and apply general and specific notes					
c.	Determine and apply dimensions on a drawing					
d.	Identify basic symbols found on a drawing					
e.	Identify tolerances on a drawing					
f.	Discuss GD&T methodology					
	2 Interpret and understand basic layout/types of drawings					
a.	Identify types of drawings					
b.	Identify parts of a drawing and list components of each					

NAME: INSTRUCTOR:

STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
	2 Interpret and understand basic layout/types of drawings cont.	1	2	3	4	5
c.	Identify types of lines on a drawing					
d.	List and describe the different views found on a drawing					
	3 Understand and analyze bill-of-materials					
a.	Determine materials required					
b.	Determine quantities required					
c.	Identify item symbol and/or part number					
	4 Ascertain job requirements from drawings					
a.	Interpret part requirements					
b.	Identify surfaces to be machined					
c.	Determine critical dimensions					
	K. PERFORM DIE OPERATIONS					
	1 Utilize basic die theory and principles of die design					
a.	Discuss shearing action on metal (3 stages)					
b.	Define / calculate cutting clearance					
c.	Define / calculate proper shut-height of die set					
d.	Define / calculate offset displacement					
e.	Define / calculate stripping pressure					
f.	Define / calculate cutting length of piece part					
g.	Define / calculate die progression					
h.	Design stock strip layout					
i.	Determine die feed direction					
j.	Explain notch, pierce, pilot, form, and cut-off stations					
k.	Determine stop block length					
l.	Determine press tonnage requirements					
m.	Define / calculate slug clearance					
n.	Explain operation of die set to make piece part					
o.	Explain spring back in form dies					
p.	Explain bending action in V-form dies					
q.	Explain coining in dies					

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STUDENT EXAMINATION: TOOL AND DIE COMPETENCIES

		RATING SCALE				
	1 Utilize basic die theory and principles of die design cont.	1	2	3	4	5
r.	Identify components of die set					
s.	Discuss materials of die components					
	2 Perform die repair					
a.	Disassemble and assemble die set					
b.	Visually inspect die components for damage					
c.	Identify component parts to be repaired / sharpened					
d.	Determine method of repairing / sharpening					
e.	Determine material for replacement parts					
f.	Manufacture replacement parts					
g.	Demonstrate setting correct punch entry					
	3 Demonstrate Die Making Skills					
a.	Identify component parts from die blueprint					
b.	Determine material / purchased parts requirements					
c.	Utilize die making procedures to make component parts					
d.	Utilize die making procedures to mount component parts					
e.	Demonstrate mounting of die set in press machine					
f.	Cycle die set in press machine and inspect operation					
g.	Inspect piece part for accuracy					
	4 Demonstrate understanding of different types of industrial dies					
a.	Describe the operation and major components of blanking or piercing dies					
b.	Describe the operation and major components of bending or forming dies					
c.	Describe the operation and major components of draw dies					
d.	Describe the operation and major components of compression dies					
e.	Describe the operation and major components of progressive dies					
f.	Describe the operation and major components of compound dies					
g.	Describe the operation and major components of combination dies					

REMARKS:

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