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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 speciality areas within the U.S. machine tool and metals-related industries. This volume provides the MAST standards and curriculum for the mold making specialty area. (A mold maker is a high-level craftsperson who is responsible for the planning, layout, set-up, and operation of hand and machine tools to perform machining operations necessary to produce a workpiece to fine and precise engineering standards.) This volume is organized in the following sections: (1) a profile of Texas State Technical College, the development center that produced these standards and curriculum; (2) a mold maker competency profile of job duties and tasks; (3) a mold 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 Practices (MTP) I; Drafting Principles; MTP II; Application Software; Introduction to Plastics; Survey of Welding Processes and Applications; Safety and Accident Prevention; Engineering Materials; Computer Assisted Design/Manufacturing (CAD/CAM) I; Mold Making I; Statics; Composites; Introduction to Computer Drafting; CAD/CAM II; Mold Making II; Strength of Materials; CAD/CAM III; Mold Making III; Mold Design and Maintenance; and Engineering Technology 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. An appendix contains industry competency profiles. (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 5

MOLD MAKING

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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

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San Diego City College

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Moraine Valley Community College

SPRINGFIELD TECHNICAL COMMUNITY COLLEGE

Texas State Technical College Waco

Machine Tool Advanced Skills Technology Program

MAST

VOLUME 5

MOLD MAKING

Supported by
The Office of Vocational and Adult Education
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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 5
MOLD MAKING

Table of Contents

FOREWORD

While the future of manufacturing in the United States is clearly one of increasing automation, computerization, use of robotics, it is misguided to envision an entire manufacturing workforce that pushes buttons or sets dials rather than using hand tools with expertise and care. Even with increasing automation there will be a continuing need for manufacturing workers highly skilled in the use of crafts-based techniques, with the occupation of Mold Maker being a case in point.

At first glance, **Mold Makers** resemble conventional machinists. They must know the operation of lathes, mills, grinders, and related machines, and often require training in computer-aided design and the programming of computer numerically controlled machines. To a much greater extent than machine operators, however, Mold Makers must possess fine eye-hand coordination, precise hand dexterity and the skill and knowledge to choose among and work with a variety of metals and composite materials. Today's conventional machinist may use hand tools in his/her daily work, but Mold Makers must be adept at their use, whether they be files, taps, reamers or dies. The combination of appropriate training and craftsmen skills continues to make the profession highly rewarding. Mold Makers are among the highest paid of the metal-working specialty occupations, earning as much as $57,000 annually after only six years in the field.

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 Mold Maker.

The diversity of skill required by Mold Makers makes identification of entry level skills difficult. Mold Makers emerging from within the industry generally possess a broad background and extensive skills in metal-working fundamentals. For those trained in an institutional setting, a minimum of two years of training is generally required. 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

mold making. Based on discussion with the other MAST consortium partners, the project presents the following definition of the new occupation:

MOLD MAKER: *The mold maker plans, lays out, sets up, and operates hand and machine tools to perform operations necessary to machine a new mold or repair/modify an existing mold to referenced design standards.*

Texas State Technical College's 101-hour training curriculum requires one year and emphasizes manufacturing materials and methods, as well as laboratory work with standard industrial equipment used in a wide variety of industries. Three options of study are offered: (1) computer-aided manufacturing; (2) machining; and (3) plastics. 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 occupational field of Mold 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
Texas State Technical College
Center for Contemporary Technology

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Manufacturing in Texas

Economic trends have led Texas officials to recognize the need to better prepare workers for a changing labor market. The downturn in the oil, natural gas, ranching and farming industries during the last decade diminished the supply of high-paying, low-skill jobs. Growth in Texas is occurring in the low paying, low skills service industry and in the high skills, high paying precision manufacturing industry. In Texas, projected increases by the year 2000 include 4,050 jobs for machine mechanics (24% growth rate); 4,700 jobs for machinists (18% growth rate); 3,850 numeric control operators (20% growth rate); and 107,150 general maintenance repair technicians (23% growth rate). The National Center for Manufacturing Sciences (NCMS) identified that of the top twenty manufacturing states, Texas experienced the largest increase in manufacturing employment. Manufacturing will add over 70,000 additional jobs in Texas by the year 2000 with increases in both durable and non-durable goods.

Texas State Technical College (TSTC)

Texas State Technical College System (TSTC) is authorized to serve the State of Texas through excellence in instruction, public service, research, and economic development. The system's efforts to improve the competitiveness of Texas business and industry include centers of excellence in technical program clusters on the system's campuses and support of educational research commercialization initiatives. Through close collaboration with business, industry, governmental agencies, and communities, including public and private secondary and postsecondary educational institutions, the system provides an articulated and responsive technical education system.

In developing and offering highly specialized technical programs and related courses, the TSTC system emphasizes the industrial and technological manpower needs of the state. Texas State Technical College is known for its advanced or emerging technical programs not commonly offered by community colleges.

New, high performance manufacturing firms in areas such as plastics, semiconductors and aerospace have driven dynamic change in TSTC's curriculum. Conventional metal fabrication to support oil and heavy manufacturing remains a cornerstone of the Waco campus and is a primary reason TSTC took the lead in developing new curricula for machining and manufacturing engineering technology in the MAST program.

Development Team

- **Project Director**: Joe K. Penick, Grant Director for Machine Tool Advanced Skills Technology Program (MAST); served as the primary administrator and academic coordinator for the MAST project.
- **Subject Matter Expert**: Wallace Pelton, Site Coordinator, was responsible for developing skill standards and course/program materials for the conventional machining, mold making and manufacturing engineering technology components of the MAST project.

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
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
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

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

FUTURE TRENDS AND CONCERNS

TEXAS STATE TECHNICAL COLLEGE WACO
MAST PROGRAM REPRESENTATIVES

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Director

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Assistant Director

JOE PENICK
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ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

Texas State Technical College Waco

COMPETENCY PROFILE

Mold Maker

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

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

MAST

MOLD MAKER ... plan, layout, setup, and operate hand and machine tools to perform operations necessary for machining a new mold or repairing/modifying an existing mold to referenced design standards.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Debur mold bases to help avoid cuts	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 draft angles	B-8 Calculate runner size for molding	B-9 Apply "shrink rate" formulas	B-10 Calculate for direct, simple, and angular indexing	B-11 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 Identify the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 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	D-6 Identify types of plastic materials	D-7 Identify plastic molding processes	D-8 Identify types of mold steels	D-9 Use pantograph for mold engraving				
E Perform Measurement/ Inspection	E-1 Identify types of measurement	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 (e.g., CMM and optical comparator							
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 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	G-4 Program CNC machines with a CAM system									
H Perform Welding Operations	H-1 Weld with Shielded Metal Arc Welding (SMAW) process	H-2 Weld/cut with oxyacetylene	H-3 Weld with Gas Tungsten Arc Welding (GTAW) (Heliarc)	H-4 Weld with Gas Metal Arc Welding (GMAW)/(MIG) and Flux Core Arc Welding (FCAW)									
I Build/Repair/ Modify Molds	I-1 Identify types of molds (e.g., three plate, multi-cavity, cam action, hot runner)	I-2 Identify typical mold components (e.g., cavity and core insert, ejector mechanisms)	I-3 Estimate basic mold cost considerations (e.g., engineering, material, labor)	I-4 Apply basic mold design principles (e.g., nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs)	I-5 Install mold temperature control devices	I-6 Disassemble / assemble molds	I-7 Identify "off the shelf" mold components	I-8 Construct a cavity and core for an injection mold	I-9 Build/ assemble/ adjust ejector plates and pins	I-10 Vent molds	I-11 Diagnose and repair all mold related problems	I-12 Perform preventive maintenance (e.g., mold cleaners, mold releases, rust preventatives)	
J Use Computers	J-1 Use computer operating systems	J-2 Use computer - inquiry systems	J-3 Use Computer Aided Drafting (CAD) software	J-4 Use various computer applications	J-5 Use mold flow software								

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.

MOLD MAKER
TECHNICAL WORKPLACE COMPETENCIES

MOLD MAKER...*plan, layout, setup, and operate hand and machine tools to perform operations necessary for machining a new mold or repairing/modifying an existing mold to referenced design standards.*

A. PRACTICE SAFETY

1. Follow Safety Manuals and All Safety Regulations/Requirements
   a. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Interpret safety manual directives
   d. Comply with established company safety practices
2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when handling molds or other heavy materials (e.g., eye bolts, slings, cables)
3. Debur Mold Bases to Help Avoid Cuts
   a. Chamfer outside edges of mold bases
   b. Do not debur parting edges of mold cavities, runners, gates, etc.
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Keep machine and hand tools clean at all times
   c. Put tools away when not in use
   d. Keep aisles clear of equipment and materials

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
2. Locate Machining Points from a Datum Point
   a. Identify points using the Cartesian coordinate system
   b. Identify points using the polar coordinate system
   c. Identify points using the absolute dimensioning system
   d. Identify points using the incremental dimensioning system
   e. Identify reasons for establishing datum point in the center of the mold base
3. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
4. Interconvert Metric/English measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
5. Perform Basic Trigonometric Functions

a. Solve for unknown angles
b. Solve for unknown sides
c. Calculate for bolt circles

6. Use Sine Bar or Sine Plate for Machine Operations
   a. Use trigonometric tables for solutions
   b. Use calculator for solutions
   c. Calculate gage block build up
7. Calculate Draft Angles
   a. Discuss reason for draft in the mold
   b. Discuss recommended draft angles for various molding processes
   c. Use D-M-E table to determine draft angles for parts of different thickness
8. Calculate Runner Size for Molding
   a. Calculate optimum runner diameter
   b. Calculate optimum runner length
9. Apply "Shrink Rate" Formulas
   a. Discuss shrink figures for various thermoplastic materials
   b. Discuss causes for shrink rate variations
   c. Apply shrink rate formulas to mold design
10. Calculate for Direct, Simple, and Angular Indexing
    a. Calculate for direct indexing
    b. Calculate for simple indexing (plain)
    c. Calculate for angular indexing
    d. Use Machinery's Handbook for calculations
11. Calculate Speeds and Feeds for Machining
    a. Calculate RPM for various metals and various tools
    b. Calculate feed for various metals, tools, and depths of cut

C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify item number symbols
   c. Identify general note symbols
   d. List the essential components found in the title block
   e. Locate bill of materials in a drawing
   f. List the components found in the revision block
3. Identify Basic Types of Drawings
   a. Identify orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)

c. Visualize one or more views from a given view
d. Identify isometric views
e. Identify exploded isometric drawings
f. Identify assembly drawings

4. List the Purpose of Each Type of Drawing
   a. Discuss purpose of orthographic (3 views) drawings
   b. Discuss purpose of isometric drawing
   c. Discuss purpose of exploded isometric drawing
   d. Discuss purpose of assembly drawings
5. Verify Drawing Elements
   a. Determine the scale of the view or section
   b. Check for revisions
   c. Recognize out-of-date blueprints
6. Identify Lines and Symbols (GD&T)
   a. Discuss the reason for GD&T
   b. Identify symbols for controlling location (or true position) of part features
   c. Identify symbols for controlling form (or alignment) of part features
   d. Identify symbols for showing datums and basic dimensions on drawings
   e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)
7. Describe the Relationship of Engineering Drawings to Planning
   a. Discuss production schedule
   b. Discuss Material Resource Planning (MRP)
   c. Discuss inventory control records
   d. Discuss shop floor routing documents
8. Use Standards to Verify Requirements
   a. Discuss the purpose of standards
   b. Discuss source locations for standards
9. Analyze Bill of Materials (BOM)
   a. Discuss components found on BOM
   b. Discuss components found in parts lists
10. Create Technical Sketches
    a. Discuss the value of sketching as a communication tool
    b. Describe basic orthographic sketching techniques
    c. Describe basic isometric sketching techniques
    d. Draw a sketch of a machine part

D. SELECT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
   a. Discuss classification system for metals
   b. Discuss general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals
2. Identify Heat Treating Processes
   a. Discuss the reasons for heat treating
   b. Discuss the time/temperature chart
   c. List the different quenching mediums
   d. Estimate metal heat temperature by color
   e. Discuss purpose of normalizing

f. Discuss purpose of annealing
g. Discuss purpose of stress relieving
h. Discuss purpose of hardening
i. Discuss purpose of tempering
j. Discuss purpose of nitriding

3. Perform Heat Treating Operations
   a. Normalize plain carbon workpiece
   b. Anneal plain carbon workpiece
   c. Stress Relieve plain carbon workpiece
   d. Harden workpiece
   e. Temper workpiece

4. Test Metal Samples for Hardness
   a. Perform spark test to test for metal hardness
   b. Perform Rockwell hardness tests
   c. Perform Brinell hardness tests
   d. Prepare metal samples for viewing under a microscope

5. Evaluate Alternative Manufacturing Processes
   a. Discuss the powder metallurgy process (PM)
   b. Discuss the following nontraditional machining processes: EDM, Laser Machining, Ultrasonic machining, Hydrojet machining, Electron beam machining, and plasma beam machining

6. Identify Types of Plastic Materials
   a. Discuss advantages of using plastics
   b. Discuss classifications of plastics
   c. Discuss forms available forms (e.g., resins, coatings, adhesives, laminates, compounds)
   d. Discuss properties

7. Identify Plastic Molding Processes
   a. Describe the blow molding process
   b. Describe the vacuum forming process
   c. Describe the injection molding process
   d. Describe the reaction injection molding process
   e. Describe the extrusion molding process
   f. Describe the compression molding process
   g. Describe the transfer molding process
   h. Describe the rotational molding process
   i. Discuss the advantages of using composites
   j. Describe the composite molding methods

8. Identify Types of Mold Steels
   a. Discuss mold service requirements
   b. Discuss mold hardness requirements
   c. Discuss machinability of mold steel
   d. Describe P-20, Plastic Mold Steel
   e. Describe A-2, Cold Work Tool Steel
   f. Describe S-1, Shock Resisting Tool Steel
   g. Describe H-13, Chromium type Hot Work Tool Steel
   h. Describe S-7, Shock Resisting Tool Steel
   i. Describe Type 414, Stainless Plastic Mold Steel

j. Describe Type 420, Stainless Plastic Mold Steel

9. Use Pantograph for Mold Engraving
   a. Describe principle of the pantograph
   b. Discuss other methods of mold engraving (e.g., CNC, EDM)

E. PERFORM MEASUREMENT/INSPECTION

1. Identify Types of Measurement
   a. Distinguish between direct and calculated measurements
   b. Compute calculated measurements
   c. Justify the use of precision measurements in manufacturing
   d. Discuss the following: precision, reliability and accuracy
   e. Demonstrate general measurement techniques
   f. Demonstrate semi-precision measurement techniques
   g. Demonstrate precision measurement techniques
   h. Document results of measurement activities and calculations
2. Select Proper Measurement Tools
   a. Match appropriate measurement tools with various types of measurement requirements
   b. Demonstrate proper measurement tool usage
   c. List steps of proper measurement
   d. Explain rationale for each step
   e. Identify error possibilities in measurement tool selection
   f. Identify error possibilities within measurement procedures
   g. Identify common conversion error possibilities
   h. Discriminate between accepted measurement procedures and improper measurement procedures
3. Apply Proper Measuring Techniques
   a. Explain calibration requirements of various precision instruments
   b. Illustrate measurement differences when taken with calibrated and non-calibrated instruments
   c. Justify use of particular measurement tools based on tool characteristics
   d. Discuss factors affecting accurate measurement (dirt, temperature, etc.)
4. Measure With Hand Held Instruments
   a. Measure with steel rules (metric and inch)
   b. Measure with micrometers
   c. Measure with comparison measuring instruments (e.g., calipers, telescope gages, etc.)
   d. Measure with direct measuring instruments (e.g., vernier, dial, and digital instruments)
   e. Measure with fixed gages (go and not go gages)
5. Measure/Layout/Inspect Using Surface Plate
   a. Describe and properly use surface plate
   b. Use surface plate accessories correctly (sine bar, gage blocks, etc.)
   c. Check for part squareness
   d. Check part dimensions for accuracy
   e. Align workpieces using height gage and dial indicators
6. Inspect Using Stationary Equipment (e.g., CMM and optical comparator)
   a. Set up and use a Coordinate Measuring Machine (CMM)

b. Set up and use an Optical Comparator

F. PERFORM CONVENTIONAL MACHINING OPERATIONS

1. Prepare and Plan For Machining Operations
   a. Read and interpret blueprints
   b. Perform basic semi-precision and precision layout as necessary
   c. Plan machining operations
   d. Understand machinability and chip formation
   e. Calculate speeds, feeds, and depth of cut for various machine applications
   f. Use carbides and other tool materials to increase productivity
   g. Use the Machinery's Handbook as a reference for machine applications
2. Use Proper Hand Tools
   a. Use arbor and shop presses
   b. Select necessary work-holding devices and hand tools as needed
   c. Select and use hand files
   d. Identify and use hand reamers
   e. Correctly identify and use hand taps as required
   f. Follow tapping procedures to produce internal threads
   g. Use thread-cutting dies to produce external threads
   h. Operate bench and pedestal grinders safely
3. Operate Power Saws
   a. Use reciprocating and horizontal band cutoff machines
   b. Operate abrasive and cold saws
   c. Prepare and use the vertical band saw
   d. Weld a bandsaw blade
4. Operate Drill Presses
   a. Describe the different types of drill presses found in the machine shop
   b. Describe and use standard drilling tools
   c. Sharpen a drill bit using a bench or pedestal grinder
   d. Setup the drill presses for drilling, countersinking, counterboring, reaming, and tapping operations
   e. Drill holes using drill jigs
5. Operate Vertical Milling Machines
   a. Demonstrate the use of all controls on the vertical milling machine
   b. Align the vertical milling machine head
   c. Select, align and use workholding devices
   d. Select milling tool holders
   e. Select milling cutters
   f. Perform all standard vertical milling operations
   g. Bore a hole using the offset boring head
   h. Machine angles using sine bar and gage blocks
   i. Setup and use special vertical mill fixtures
   j. Setup and machine dovetails
   k. Machine keyways
6. Operate Horizontal Milling Machines
   a. Discuss the difference in plain and universal horizontal milling machines
   b. Discuss the types of spindles, arbors and adaptors used on the horizontal milling machine

c. List several common work holding methods
d. Use plain milling cutters
e. Use side milling cutters
f. Use face milling cutters
g. Setup and use special horizontal mill fixtures

7. Operate Metal Cutting Lathes
   a. Demonstrate the use of all controls on the engine lathe
   b. Discuss standard tools and toolholders for the lathe
   c. Face and center drill parts correctly
   d. Drill, ream and bore on the lathe
   e. Turn between centers
   f. Discuss alignment of lathe centers
   g. Make all calculations, lathe adjustments and settings to machine sixty-degree internal and external threads
   h. Discuss thread fit classifications
   i. Make all calculations, lathe adjustments and settings to machine Acme threads
   j. Describe the common tapers used in the machine shop
   k. Discuss taper cutting and calculations for the lathe
   l. Setup and use the taper attachment found on most lathes
   m. Use follower rests and steady rests
   n. Use HSS cutting tools
   o. Use carbide cutting tools
   p. Setup and operate tracer lathes
   q. Setup and operate turret lathes
8. Operate Grinding/Abrasive Machines
   a. Discuss the selection and identification of grinding wheels
   b. Inspect, mount, true, dress, and balance grinding wheels
   c. True table by indicator
   d. True back rail by indicator
   e. Make the form in the wheel
   f. Check the form in the wheel
   g. Discuss the selection of grinding fluids
   h. Operate horizontal spindle reciprocating table surface grinders
   i. Operate cylindrical grinders
   j. Operate ID and OD grinders
   k. Setup and operate tool and cutter grinders
   l. Discuss common problems and solutions in surface grinding
   m. Operate honing machine
   n. Operate lapping machines
9. Operate Jig Boring Machines
   a. Discuss jig bore accessories
   b. Operate conventional jig bore to locate and bore holes
   c. Demonstrate proper use of scopes
10. Operate Deburring Equipment
   a. Debur parts using pneumatic Deburring tools
   b. Debur parts using electric deburring tools
11. Polish Mold Cavities

a. Discuss finish requirements of molds
b. Discuss surface finish symbols
c. Select abrasive for mold finishing
d. Describe steps for achieving "mirror" finish
e. Describe molding problems related to poor surface conditions

G. PERFORM ADVANCED MACHINING PROCESSES

1. Program Computer Numerical Control (CNC) Machines
   a. Identify CNC applications
   b. Identify advantages of CNC
   c. List various types of CNC machines
   d. Discuss CNC machine control systems
   e. Describe absolute and incremental coordinate systems
   f. Demonstrate proper selection of CNC tooling
   g. Plan and write programs for CNC lathes
   h. Plan and write programs for CNC mills
   i. Use a "CAM" system to program CNC mills and lathes
   j. Discuss adaptive control
2. Operate CNC Machining Centers and Turning Centers
   a. Install and align work holding devices
   b. Load tools into machine
   c. Set tool length offset and tool diameter compensation
   d. Establish machine reference
   e. Load programs into CNC machines
   f. Demonstrate proper operation of CNC machining center to include "dry run" and final production
   g. Demonstrate proper operation of CNC turning center to include "dry run" and final production
   h. Discuss proper coolant selection
3. Operate Electrical Discharge Machines
   a. Discuss the EDM process
   b. List advantages and disadvantages of the EDM process
   c. Identify electrode materials
   d. Machine EDM electrodes
   e. Setup and operate die sinker EDM machines
   f. Calculate overburn
   g. Identify generator setting of machine
   h. Choose proper techniques for flushing
   i. Estimate number of roughers and finishers
   j. Demonstrate proper electrode mounting techniques
   k. Utilize 3R tooling
   l. Perform touch-off procedures
   m. Recognize optimum machine settings
   n. Perform continuity checks
   o. Determine R-MAX finish required
   p. Setup and operate wire cut EDM machines
4. Program CNC Machine With a CAM System
   a. Install CAM software on a personal computer

b. Plan machine operations
c. Select tools/speeds/feeds for optimum cutting
d. Create manufacturing models using a CAM system
e. Review part geometry to verify tool path
f. Edit models using a CAM system
g. Generate CNC code using a CAM system
h. Write post processors for a CAM system
i. Transfer CAM files to a CAD system

H. PERFORM WELDING OPERATIONS

1. Weld With Shielded Metal Arc Welding (SMAW) Process
   a. Discuss factors for welding electrode selection
   b. Adjust welding amperage setting for each application
   c. Demonstrate proper use of safety equipment
   d. Weld beads on plate (flat, horizontal, and vertical)
   e. Weld tee joints (flat, horizontal, and vertical)
   f. Weld pipe joints
   g. Discuss weld inspection factors and techniques
2. Weld/Cut With Oxyacetylene
   a. Setup and break down the oxyacetylene welding/cutting station
   b. Discuss proper settings for oxyacetylene regulators
   c. Discuss factors that determine torch welding and cutting tip selection
   d. Demonstrate routine torch maintenance procedures
   e. Weld beads on plate (with and without filler) in the flat and horizontal positions
   f. Weld square groove butt joints in the flat and horizontal positions
   g. Braze weld beads on plate in the flat position
   h. Make square cuts to a straight line with the cutting torch
   i. Demonstrate proper use of safety equipment
3. Weld With Gas Tungsten Arc Welding (GTAW) (Heliarc)
   a. Properly set up GTAW welder for welding steel
   b. Properly set up GTAW welder for welding aluminum
   c. Weld beads on plate (steel) with appropriate filler rod in the flat position
   d. Weld beads on plate (aluminum) with appropriate filler rod in the flat position
   e. Weld lap joints in the horizontal position on steel plate
   f. Weld lap joints in the horizontal position on aluminum plate
   g. Demonstrate proper use of safety equipment
4. Weld With Gas Metal Arc Welding (GMAW)/(MIG) and Flux Core Arc Welding (FCAW)
   a. Set up machine for gas metal arc welding
   b. Set up machine for flux cored arc welding
   c. Weld beads on plate with gas metal arc welding system in the flat position
   d. Weld beads on plate with flux cored welding system in the flat position
   e. Weld lap joints on steel plate with the gas metal arc welding system in the horizontal position
   f. Weld lap joints on steel plate with the flux cored arc welding system in the horizontal position

I. BUILD/REPAIR/MODIFY MOLDS

1. Identify Types of Molds (e.g., three plate, multi-cavity, cam action, hot runner)
   a. Identify/describe three plate mold
   b. Identify/describe multi-cavity molds
   c. Identify/describe runnerless molds
   d. Identify/describe cam action molds
2. Identify Typical Mold Components (e.g., cavity and core insert, ejector mechanisms, etc.)
   a. Identify/describe cavity inserts
   b. Identify/describe core inserts
   c. Describe engraving inserts
   d. Identify/describe ejector pins, blades and ejector plates
   e. Identify/describe stripper plates and rings
   f. Discuss and/or install compressed air ejector systems
3. Estimate Basic Mold Cost Considerations (e.g., engineering, material, labor)
   a. Discuss factors relating to molding process (high vs. low pressure)
   b. Discuss factors relating to molding material (hard vs. easy flow)
   c. Discuss factors relating to volume
   d. Discuss factors relating to part size
   e. Discuss factors relating to part complexity
   f. Discuss factors relating to part tolerances
4. Apply Basic Mold Design: Principles (nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs)
   a. Describe types of runner systems (e.g., full, half, quarter, trapezoidal, and modified trapezoidal)
   b. Describe laminar and turbulent flow
   c. Discuss the purpose of cold slug extensions
   d. Discuss recommended runner size for various materials
   e. Discuss common gate types (e.g., jump, tunnel, tab, ring, sprue, center, fan)
   f. Discuss mold venting (e.g., location, size, solutions)
   g. Discuss wall thickness
   h. Discuss part radius considerations
   i. Discuss rib design and placement
   j. Discuss draft angles
5. Install Mold Temperature Control Devices
   a. Describe mold baffles
   b. Describe mold bubblers
   c. Describe design of water line placements
   d. Discuss mold cooling problems
6. Disassemble/Assemble Molds
   a. Completely disassemble a mold base
   b. Identify all components
   c. Assemble mold base to working condition
7. Identify "Off the Shelf" Mold Components
   a. Identify sources of molding components
   b. Use catalogues to order components for mold construction
8. Construct a Cavity and Core for an Injection Mold

a. Machine a cavity for a mold
b. Machine a core for a mold
c. Install the components into the mold
d. Check for proper mold operation

9. Build/Assemble/Adjust Ejector Plates and Pins
   a. Select proper type of ejector mechanism
   b. Determine size and placement of ejectors
   c. Locate, drill and assemble ejector plate w/ejector pins
   d. Assemble, measure, and final grind ejector lengths for proper clearance
   e. Check final operation of ejector mechanism
10. Vent Molds
   a. Determine mold vent requirements
   b. Determine mold size requirements
   c. Determine optimum mold locations
   d. Machine vent openings
   e. Hand finish vent to cavity openings
   f. Check final operation for "flash" and proper mold filling
11. Diagnose and Repair all Mold Related Problems
   a. Discuss possible solutions for mold thermal conductivity balancing
   b. Discuss possible solutions for highly stressed molding related problems
   c. Discuss possible solutions for defective surface conditions and voids
   d. Discuss possible solutions for long molding cycle times
   e. Discuss possible solutions for inability to fill thin sections or large areas
   f. Discuss possible solutions for ejection difficulties
   g. Discuss possible solutions for corrosion of cooling channels
   h. Discuss other problems such as thermal isolation and thermal expansion
12. Perform Preventative Maintenance (e.g., mold cleaners, mold releases, rust preventatives)
   a. Select/use mold cleaners
   b. Select/use mold releases
   c. Select/use rust preventatives
   d. Use "soft tools" around mold cavities

J. USE COMPUTERS

1. Use Computer Operating Systems
   a. Use basic computer terminology appropriately and accurately
   b. Boot the computer and recognize the basic components of DOS
   c. Use DOS to perform file management
   d. Use DOS to perform directory management
   e. Install software packages on a PC
2. Use Computer Inquiry Systems
   a. Log in to a multi-user system
   b. Access system for needed information
   c. Print reports as necessary
3. Use Computer Aided Drafting (CAD) Software
   a. Demonstrate the start-up and shut-down of a PC based CAD system
   b. Input information through the use of various input devices

c. Use the SETTINGS menu commands to establish operating parameters in a drawing
d. Use the Cartesian coordinate system to correctly enter line and arc elements to construct a part
e. Use the DISPLAY menu to manipulate the drawing image
f. Apply basic DRAW menu and EDIT menu commands to create a drawing
g. Use appropriate menu commands to manage files
h. Set up the specifications within the PLOT command for producing a hard copy of a drawing
i. Convert to accepted drawing exchanges formats (e.g., IGES, DXF)
j. Convert CAD data to a CAM system
k. Use a CAD system for producing too drawings
l. Create 3-D Solid Models

4. Use Various Computer Applications
   a. Load word processor, create, save, retrieve, edit, and print a document
   b. Load spreadsheet, create, save, retrieve, edit, and print a worksheet
   c. Load database programs, create, save, retrieve, edit, and print records in a database file
5. Use Mold Flow Software
   a. Designs parts using Mold Flow software
   b. Perform molding analysis using Mold Flow software

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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.

MANUFACTURING ENGINEERING TECHNOLOGY
MOLD MAKING (Recommended)
CURRICULUM

		LEC	LAB	CR
FIRST QUARTER				
MET 100	Machine Tool Practices I	3	9	6
DDT 104	Drafting Principles	2	4	3
ENGL 1301*	Composition I	4	0	3
MATH 1314*	College Algebra	4	0	3
PSYC 1100*	College Success Skills	1	0	1
		14	13	16
SECOND QUARTER				
MET 200	Machine Tool Practices II	3	9	6
ENGL 134*	Interpersonal Communication	4	0	3
CNS 2060	Application Software	2	4	3
MATH 1316*	Plane Trigonometry	4	0	3
		13	13	15
THIRD QUARTER				
MET 201	Introduction to Plastics	2	2	3
WLT 105	Survey of Welding Processes and Applications	3	3	4
OSH 216	Safety and Accident Prevention	2	3	3
MET 112	Engineering Materials	2	3	3
PSYC 2301*	General Psychology	4	0	3
		13	11	16
FOURTH QUARTER				
MET 302	CAD/CAM I	3	3	4
MET 211	Mold Making I	3	9	6
MET 206	Statics	3	3	4
MET 345	Composites	1	3	2
DDT 128	Introduction to Computer Drafting	1	4	2
		11	22	18
FIFTH QUARTER				
MET 318	CAD/CAM II	3	3	4
MET 309	Mold Making II	3	9	6
MET 312	Strength of Materials	3	3	4
PHYS 1310*	Elementary Physics	4	0	3
		13	15	17
SIXTH QUARTER				
MET 406	CAD/CAM III	2	6	4
MET 347	Mold Making III	3	8	6
MET 330	Mold Design and Maintenance	2	3	3
MET 322	Engineering Technology Project	4	6	6
		11	23	19
	Program Totals	75	97	101

* Course Syllabi in Volume 2

MANUFACTURING ENGINEERING TECHNOLOGY
MOLD MAKING
COURSE DESCRIPTIONS
1995-1996

MET 100 Machine Tool Practices I (3-9-6) Students will be assigned, specially designed projects that will be machined using the engine lathe, milling machine, drill press, and various saws. The capability and safe use of the machine tools will be stressed.

MET 112 Engineering Materials (2-3-3) A study of metallic and nonmetallic materials used in design including properties, characteristics, and methods of conducting common tests and interpreting data.

MET 200 Machine Tool Practices II (3-9-6) A course designed to develop additional machine shop skills for those students who were successful in Machine Tool Practices I.

MET 201 Introduction to Plastics (2-2-3) This is a survey course designed to introduce the student to the field of plastics. This overview will include both thermoplastic and thermoset materials along with the major processing methods being utilized by industry today.

MET 206 Statics (3-3-4) An introduction to the field of engineering mechanics covering the calculation of forces and moments acting on machine parts, frames and structures. The equilibrium of concurrent and coplanar force systems, centroids and friction are studied. Prerequisite: Plane Trigonometry or concurrent enrollment

MET 211 Mold Making I (3-9-6) Introduces students to the field of mold making for the plastic injection industry. Focus is placed on mold theory, mold repair, identification of problems and their correction as related to thermal plastic injection molds, standardization of mold components, mold blueprint reading, machine shop skills necessary for mold making, and preventative mold maintenance for injection molds.

MET 302 CAD/CAM I (3-3-4) This course will provide an introduction to "Process Modeling" utilizing the CNC graphics programming system; SMARTCAM". Using engineering drawings students will program various parts for both CNC mills and CNC lathes. Related topics include: job planning, tool selection, construction of a process model, tool path verification, simulation, quality control, CAD/CAM data transfer, and CNC code generation.

MET 309 Mold Making II (3-9-6) This course is designed to give students desiring to work as machinists in the plastic injection molding industry the necessary basic skills to operate electrical discharge machines. In addition, this course will give students the necessary basic skills of stoning and polishing, as well as hands on experience necessary to manufacture mold plates and ejection systems. Prerequisite: Mold Making I

MET 312 **Strength of Materials** (3-3-4) A study of the relationship existing between externally applied forces and internally induced stresses, and the resulting deformations of structural members. Prerequisite: Statics

MET 318 **CAD/CAM II** (3-3-4) A continuation of CAD/CAM I with advanced utilization of "SMARTCAM". Topics will include the following: 3-D Process Modeling, creation and utilization of different work planes, 4th and 5th axis programming, creation of tool path for surface primitives, swept surfaces, translated surfaces, sculpted surfaces, ruled surfaces, and coons surfaces. Additional topics include: projecting, intersecting, blending, and trimming one surface to another surface. Students will program both a simple punch and die set and a simple injection mold cavity. Prerequisite: CAD/CAM I

MET 322 **Engineering Technology Project** (4-6-6) Different industrial level projects emphasizing manufacturing applications/research in the areas of CAD/CAM, CIM or plastics will be assigned to students utilizing a team concept.

MET 330 **Mold Design and Maintenance** (2-3-3) An introductory course on the basic design parameters of plastic injection molds, including mold flow, nominal walls projection, depressions, ejector systems, runners, gates, parting lines, and general mold configurations. Maintenance techniques are practiced on in house molds.

MET 345 **Composites** (1-3-2) An introductory course showing the benefits of combining various types of reinforcing elements (fibers) with a polymer resin (matrix) to yield specific characteristics and properties not attainable by either constituent acting alone.

MET 347 **Mold Making III** (3-8-6) This course is designed to give students hands-on experience with making injection mold cores, cavities, hardening and grinding, as well as making a proto-type injection mold of their design. Prerequisites: Mold Making I and Mold Making II

MET 406 **CAD/CAM III** (2-6-4) A continuation of CAD/CAM II with advanced utilization of "SMARTCAM". Advanced topics will include the following: 3-D Process Modeling, creation and utilization of different work planes, 4th and 5th axis programming, creation of tool path for surface primitives, swept surfaces, translated surfaces, sculpted surfaces, ruled surfaces, and coons surfaces. Additional advanced topics include: projecting, intersecting, blending, and trimming one surface to another surface. Emphasis will be placed on programming CNC turning centers and CNC Electrical Discharge Machines (EDM). Most laboratory exercises will focus on CAD/CAM programming for the mold making option; therefore most live work will consist of injection and other plastic molding projects. Prerequisite: CAD/CAM I and CAD/CAM II

MANUFACTURING ENGINEERING TECHNOLOGY
MOLD MAKING
SUPPORT COURSES
1995-1996

DDT 104	**Drafting Principles** A course consisting of basic exercises in lettering, use of the instruments, technical sketching, geometric construction, orthographic projection, auxiliary views, and dimensioning. Working drawings will be made.
ENGL 1301*	**Composition I** Students study the process of composing essays, including prewriting techniques, drafting, and revising and editing. Students write several multi-paragraph essays of various types, in both in-class and out-of-class settings. Students critically analyze sample student and professional essays. Prerequisite: ENGL 020, Writing Skills II, or equivalent as determined by the English placement test.
MATH 1314*	**College Algebra** A study of quadratics; polynomial, rational, logarithmic and exponential functions; systems of equations, progressions; sequences and series; matrices and determinants. Prerequisite: MATH 104, Intermediate Algebra, or equivalent as determined by MATH placement test.
PSYC 1100*	**College Success Skills** This course acquaints the students with the policies of the college, services available on and off the campus, and study skills along with other issues that will help them through their college studies. Students are required to take this course in their first quarter at TSTC.
ENGL 134*	**Interpersonal Communication** Theories and exercises in verbal and nonverbal communication with focus on interpersonal relationships. Students will study internal and external factors that impact communication, communication clarification, and conflict resolution. Various presentations are required. Prerequisite: ENGL 1301, Composition I.
CNS 2060	**Application Software** This course includes introductory concepts combined with an emphasis on the more predominate computer software including, but not limited to DOS, word processing, electronic spreadsheets, and databases, thus providing non-majors with computer literacy and hands-on experience.
MATH 1316*	**Plane Trigonometry** Topics in trigonometric functions, right triangles, trigonometric identities, radian measure, graphs of periodic functions, and oblique triangles. Prerequisite: MATH 1314, College Algebra.

OSH 216	**Safety and Accident Prevention** A course designed to enable the student to recognize hazards and potential hazards which may occur in the workplace and to take corrective action. The course may be directed toward a specific technology as required. Federal safety requirements under the OSHA law will be emphasized. General supervisor safety training course for all technologies.
PSYC 2301*	**General Psychology** A survey of the major topics in psychology, introducing the study of behavior and the factors that determine and affect behavior.
DDT 128	**Introduction to Computer Drafting** This course introduces the student to Computer-Aided Drafting (CAD). This introduction involves equipment software and basic command logic. Graphic images are created using introductory level commands. Recommended for Non-Majors.
PHYS 1310*	**Elementary Physics** An algebra-level problem-oriented course. Presents special topics in classical physics, such as basic mechanics, optics, acoustics, or electricity. Prerequisite: MATH 1314, College Algebra, or above.
WLT 105	**Survey of Welding Processes and Applications** This course is a survey of shielded metal arc, gas tungsten arc, gas metal arc, flux cored arc, and submerged arc welding processes. Metals weldability and weld symbols are considered. Process safety, electrode selection, and process parameters are emphasized. Hard surfacing using shielded metal arc and oxyacetylene processes and techniques are studied. It is recommended that the student have some knowledge of the welding processes before enrollment in this course.

* Course syllabi in Volume 2

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: MOLD MAKING

	Machine Tool Practices I	Drafting Principles	Machine Tool Practices II	Application Software	Introduction to Plastics	Survey of Weld. Process./Appl.	Safety/Accident Prevention	Engineering Materials	CAD/CAM I	Mold Making I	Statics	Composites	Intro. to Computer Drafting	CAD/CAM II	Mold Making II	Strength of Materials	CAD/CAM III	Mold Making III	Mold Design & Maintenance		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	X		4
A-2 Use Protective Equipment	X		X			X	X		X	X		X		X	X		X	X	X		4
A-3 Debur Mold Bases to Help Avoid Cuts										X					X			X	X		4
A-4 Maintain a Clean and Safe Work Environment	X		X			X	X		X	X		X		X	X		X	X	X		4
B. APPLY MATHEMATICAL CONCEPTS																					
B-1 Perform Basic Arithmetic Functions	X		X					X	X	X	X			X	X	X	X	X	X		4
B-2 Locate Machining Points from a Datum Point			X						X	X			X	X	X		X	X	X		4
B-3 Interconvert Fractions/Decimals	X		X						X	X	X			X	X	X	X	X	X		4
B-4 Interconvert Metric/English Measurements	X		X						X	X	X			X	X	X	X	X	X		3
B-5 Perform Basic Trigonometric Functions	X		X						X	X	X			X	X	X	X	X	X		4
B-6 Use Sine Bar or Sine Plate for Machine Operations			X												X						2
B-7 Calculate Draft Angles										X					X		X	X	X		3
B-8 Calculate Runner Size for Molding										X					X		X	X	X		3
B-9 Apply "Shrink Rate" Formulas										X					X		X	X	X		2
B-10 Calculate for Direct, Simple, and Angular Indexing			X																X		2
B-11 Calculate Speeds and Feeds for Machining	X		X					X		X				X	X		X	X	X		4
C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS																					
C-1 Review Blueprint Notes and Dimensions	X	X	X					X		X				X	X		X	X	X		4
C-2 Identify Basic Layout of Drawings	X	X	X					X		X				X	X		X	X	X		4
C-3 Identify Basic Types of Drawings	X	X	X					X		X				X	X		X	X	X		4
C-4 List the Purpose of Each Type of Drawing	X	X	X					X		X				X	X		X	X	X		4
C-5 Verify Drawing Elements	X	X	X					X		X				X	X		X	X	X		4
C-6 Identify Lines and Symbols (GD&T)	X	X	X			X		X		X				X	X		X	X	X		3
C-7 Describe the Relationship of Engineering Drawings to Planning	X	X	X					X		X				X	X		X	X	X		3
C-8 Use Standards to Verify Requirements	X	X	X					X		X				X	X		X	X	X		3
C-9 Analyze Bill of Materials (BOM)		X	X			X				X				X	X		X	X	X		3
C-10 Create Technical Sketches		X								X					X		X		X		2
D. SELECT MANUFACTURING MATERIALS AND PROCESSES																					
ify Materials With Desired Properties	X		X		X	X		X		X	X	X			X	X		X	X		3

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY: MOLD MAKING

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D-2 Identify Heat Treating Processes								X		X					X			X	X
D-3 Perform Heat Treating Operations								X											X
D-4 Test Metal Samples for Hardness								X										X	X
D-5 Evaluate Alternative Manufacturing Processes			X		X	X		X		X	X	X			X	X		X	X
D-6 Identify Types of Plastic Materials					X					X					X			X	X
D-7 Identify Plastic Molding Processes					X					X					X				X
D-8 Identify Types of Mold Steels																		X	X
D-9 Use Pantograph for Mold Engraving																		X	X
E. PERFORM MEASUREMENT/INSPECTION																			
E-1 Identify Types of Measurement	X		X							X					X		X	X	X
E-2 Select Proper Measurement Tools	X		X							X					X		X	X	X
E-3 Apply Proper Measuring Techniques	X		X							X					X		X	X	X
E-4 Measure With Hand Held Instruments	X		X							X					X		X	X	X
E-5 Measure/Layout/Inspect Using Surface Plate	X		X							X					X		X	X	X
E-6 Inspect Using Stationary Equipment (e.g., CMM; optical comparator)			X							X					X		X	X	X
F. PERFORM CONVENTIONAL MACHINING OPERATIONS																			
F-1 Prepare and Plan for Machining Operations	X		X						X					X	X		X	X	X
F-2 Use Proper Hand Tools	X		X							X					X		X	X	X
F-3 Operate Power Saws	X		X							X					X		X	X	X
F-4 Operate Drill Presses	X		X							X					X		X	X	X
F-5 Operate Vertical Milling Machines	X		X							X					X		X	X	X
F-6 Operate Horizontal Milling Machines			X							X					X		X	X	X
F-7 Operate Metal Cutting Lathes			X							X					X		X	X	X
F-8 Operate Grinding/Abrasive Machines										X					X		X	X	X
F-9 Operate Jig Boring Machines			X							X					X		X	X	X
F-10 Operate Deburring Equipment										X					X		X	X	X
F-11 Polish Mold Cavities										X					X		X	X	X
G. PERFORM ADVANCED MACHINING PROCESSES																			
G-1 Program Computer Numerical Control (CNC) Machines									X					X			X	X	X
G-2 Operate CNC Machining Centers and Turning Centers									X					X			X	X	

Technical Workplace Competencies/Course

CROSSWALK

TECHNICAL COMPETENCY: MOLD MAKING

	Machine Tool Practices I	Drafting Principles	Machine Tool Practices II	Application Software	Introduction to Plastics	Survey of Weld. Process./Appl.	Safety/Accident Prevention	Engineering Materials	CAD/CAM I	Mold Making I	Statics	Composites	Intro. to Computer Drafting	CAD/CAM II	Mold Making II	Strength of Materials	CAD/CAM III	Mold Making III	Mold Design & Maintenance		EXIT PROFICIENCY LEVEL
G-3 Operate Electrical Discharge Machines																	X	X	X		3
G-4 Program CNC Machine With a CAM System									X					X			X	X	X		4
H. PERFORM WELDING OPERATIONS																					
H-1 Weld With Shielded Metal Arc Welding (SMAW) Process						X													X		3
H-2 Weld/Cut With Oxyacetylene						X													X		3
H-3 Weld With Gas Tungsten Arc Welding (GTAW) (Heliarc)						X													X		3
H-4 Weld With Gas Metal Arc Welding (GMAW)/(MIG) and Flux Core Arc Welding (FCAW)						X													X		3
I. BUILD/REPAIR/MODIFY MOLDS																					
I-1 Identify Types of Molds (e.g., three plate, multi-cavity, cam action, hot runner)										X					X		X	X	X		4
I-2 Identify Typical Mold Components (e.g., cavity and core insert, ejector mechanisms, etc.)										X					X			X	X		4
I-3 Estimate Basic Mold Cost Considerations (e.g., engineering, material, labor)										X					X			X	X		3
I-4 Apply Basic Mold Design: Principles (nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs)										X					X			X	X		4
I-5 Install Mold Temperature Control Devices										X					X			X	X		4
I-6 Disassemble/Assemble Molds										X					X			X	X		4
I-7 Identify "Off the Shelf" Mold Components										X					X			X	X		4
I-8 Construct a Cavity and Core for an Injection Mold										X					X			X	X		4
I-9 Build/Assemble/Adjust Ejector Plates and Pins										X					X			X	X		4
I-10 Vent Molds										X					X			X	X		4
I-11 Diagnose and Repair all Mold Related Problems										X					X			X	X		4
I-12 Perform Preventative Maintenance (e.g., mold cleaners, mold releases, rust preventatives)										X					X			X	X		4
J. USE COMPUTERS																					
J-1 Use Computer Operating Systems				X						X			X	X			X	X	X		4
J-2 Use Computer Inquiry Systems				X						X			X	X			X	X	X		4
J-3 Use Computer Aided Drafting (CAD) Software													X								3
J-4 Use Various Computer Applications				X						X			X	X			X	X	X		3
J-5 Use Mold Flow Software																		X	X		2

MOLD MAKER
TECHNICAL WORKPLACE COMPETENCIES
EXIT LEVEL PROFICIENCY MATRIX

Mold Maker: plan, layout, set up, and operate hand and machine tools to perform operations necessary for machining a new mold or repairing/modifying an existing mold to referenced design standards.

The following matrix identifies the five exit levels of technical workplace competencies for the Machinist Certificate at Texas State Technical College Waco.

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

MOLD MAKING

COMPETENCY	Machine Tool Practices I	Drafting Principles	Machine Tool Practices II	Application Software	Introduction to Plastics	Survey of Weld. Process./Appl.	Safety/Accident Prevention	Engineering Materials	CAD/CAM I	Mold Making I	Statics	Composites	Intro. to Computer Drafting	CAD/CAM II	Mold Making II	Strength of Materials	CAD/CAM III	Mold Making III	Mold Design & Maintenance		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		4
B. Allocates money	X		X		X	X				X					X			X	X		3
C. Allocates material and facility resources	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		3
D. Allocates human resources	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		4
(IN) INTERPERSONAL SKILLS:																					
A. Participates as a member of a team	X		X			X	X			X		X			X			X	X		3
B. Teaches others	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		3
C. Serves clients/customers										X					X			X	X		2
D. Exercises leadership	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		3
E. Negotiates										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		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		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		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		4
D. Uses computers to process information				X					X				X	X			X	X	X		3
(SY) SYSTEMS:																					
A. Understands systems	X	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		4
C. Improves and designs systems			X							X	X	X		X	X		X	X	X		3
(TE) TECHNOLOGY:																					
A. Selects technology	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		4
C. Maintains and troubleshoots technology	X		X			X		X	X	X			X	X	X		X	X	X		3

SCANS/Course

CROSSWALK

MOLD MAKING

FOUNDATION SKILLS	Machine Tool Practices I	Drafting Principles	Machine Tool Practices II	Application Software	Introduction to Plastics	Survey of Weld. Process./Appl.	Safety/Accident Prevention	Engineering Materials	CAD/CAM I	Mold Making I	Statics	Composites	Intro. to Computer Drafting	CAD/CAM II	Mold Making II	Strength of Materials	CAD/CAM III	Mold Making III	Mold Design & Maintenance
(BS) BASIC SKILLS:																			
A. Reading	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
B. Writing	X	X	X		X		X	X	X	X	X	X	X	X	X	X	X	X	X
C. Arithmetic and mathematics	X	X	X	X	X				X	X	X		X	X	X	X	X	X	X
D. Listening	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
E. Speaking	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
(TS) THINKING SKILLS:																			
A. Creative thinking	X	X	X	X	X	X			X	X	X		X	X	X	X	X	X	X
B. Decision making	X	X	X	X		X	X		X	X	X		X	X	X	X	X	X	X
C. Problem solving	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
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
E. Knowing how to learn	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
F. Reasoning																			
(PQ) PERSONAL QUALITIES:																			
A. Responsibility	X																		
B. Self-esteem	X																		
C. Social	X																		
D. Self-management	X																		
E. Integrity/honesty	X																		

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 it's "AMERICA 2000 REPORT' the following five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance:

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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.

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/01/012296

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 PRACTICES I

MAST PROGRAM
COURSE SYLLABUS
MACHINE TOOL PRACTICES I

Lecture hours/week: 3 **Lab hours/week: 9** **Credit hours: 6**

COURSE DESCRIPTION:

Students will be assigned specifically designed projects that will be machined using the engine lathe, milling machine, drill press, and various saws. The capability and safe use of machine tools will be stressed.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
Lab Manual: Machine Tool Practices I, Raborn, TSTC Pub., 4th Ed.

Student Tool List	**Qty. Req'd.**
Tool Box	1
Safety Glasses	1 pair
6 inch Ruler	1/8, 1/16, 1/32, and 1/64 inch
Ball Peen Hammer	1
10 inch Adjustable Wrench	1
Center Punch	1
Magic marker, Jumbo, black.	1
Aluminum Oxide Cloth, 9" X 11", 240 Grit	2 sheets
Aluminum Oxide Cloth, 9" X 11", 320 Grit	2 sheets
Tool Steel, 3/8", H.S.S.	2
Flat Mill Bastard File, 10 inch.	1
File Handle	1
Allen Wrench Set, Long English and Metric	1 each
Center Drill #3	1
Scribe	1
Center Gage	1
Screw Driver, 8 inch	1
File Card Brush	1
0-6 inch Dial Calipers	1
Shop Apron (blue denim)	1
Shop Towels (1 roll)	1

METHODS 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 and oral presentations
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 the Course	---	1
Safety	5-12	1
Tool Grinding	43-45 (lab book)	1
The Machine Shop	1-4	1
The Inch Rule	113-118	1
The Square	163-166	1
The Inch Micrometer	140-145	1
Drawings	28-36	2
Layout Tools	249-262	2
QUIZ I (over above lectures)	---	1
Semi-precision Layout	262-266	1
Hand Tools	46-55	1
Hacksaws	55-58	1
Files	58-63	1
Verniers	122-125	1
Vernier Micrometers	151-156	1
The Drill Press	365-374	1
Drilling Tools	375-384	2
QUIZ 2 (over above lectures)	---	1
Drilling Operations	389-402	2
Taps	68-74	1
Tapping Procedures	74-79	1
Gage Blocks	178-187	1
Angular Measuring	187-195	1

Precision Layout	267-280	2
QUIZ 3 (over above lectures)	---	1
Oral Presentations*	---	5
	Total Lecture Hours	**36**

**(10-15 minute student presentations on assigned machine-related topics. These topics could include future trends or special concerns of the machine tool industry.)*

LAB OUTLINE:

Lab Topics	Contact Hrs.
Shop orientation	2
Use of the cut-off saw	2
Grinding a lathe tool	3
Grinding a mill tool	3
Using the band saw	3
Using the radial drill	3
Using the sensitive drill	3
Bench work	27
Lathe work	27
Mill work	27
Leaving the shop in order	3
Inspecting the finished work	5
Total Lab Hours	**108**

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. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Comply with established safety practices
2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when necessary
3. Follow Safe Operating Procedures for Hand and Machine Tools
   a. Understand and apply safe machine operating procedures
   b. Demonstrate safe machine operation
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Clean machine/hand tools when work is completed
   c. Put tools away when work is finished

d. Keep aisles clear of equipment and materials

B. APPLY MATHEMATICAL CONCEPTS

1. Calculate Speeds and Feeds for Machining
   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut

C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify general note symbols
3. Identify Basic Types of Drawings
   a. Identify orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)
   c. Visualize one or more views from a given view
4. List the Purpose of Each Type of Drawing
   a. Identify the purpose of orthographic (3 views) drawings

D. PERFORM MEASUREMENT/INSPECTION

1. Identify Types of Measurement
   a. Discuss the use of metrology in manufacturing
   b. Discuss the inch system of measurement
   c. Discuss the metric system of measurement
   d. Discuss semi-precision and precision measurement
   e. Discuss the following: accuracy, precision, reliability, and discrimination
2. Select Proper Measurement Tools
   a. Identify basic semi-precision measuring tools
   b. Identify precision measuring tools
   c. Justify the use of a particular measuring tool based on tool characteristics
   d. Identify error possibilities in measurement tool selection
   e. Demonstrate proper care of precision measuring tools
3. Apply Proper Measuring Techniques
   a. Discuss factors affecting accurate measurement (dirt, temperature, improper measuring tool calibration)
   b. Explain calibration requirements of various precision instruments
   c. Illustrate measurement differences when taken with calibrated and non-calibrated instruments
   d. Calibrate a micrometer type measuring tool
4. Perform Measurements With Hand Held Instruments
   a. Measure with steel rules (metric and inch)
   b. Measure with micrometers

c. Measure with comparison measuring instruments (e.g., calipers, telescope gages)
d. Measure with direct measuring instruments (e.g., vernier, dial, and digital instruments)
e. Measure with fixed gages (go and not go gages)

5. Perform Measurements on Surface Plate
   a. Describe care of surface plate
   b. Use surface plate accessories correctly (sine bar, gage blocks, etc.)
   c. Check for part squareness
   d. Check part dimensions for accuracy
   e. Align workpieces using height gage and dial indicators

E. PERFORM CONVENTIONAL MACHINING OPERATIONS

1. Prepare and Plan For Machining Operations
   a. Read and interpret blueprints
   b. Perform basic semi-precision and precision layout as necessary
   c. Plan machining operations
   d. Calculate speeds, feeds, and depth of cut for various machine applications
   e. Use carbides and other tool materials to increase productivity
2. Use Proper Hand Tools
   a. Use arbor and shop presses
   b. Select necessary work-holding devices and hand tools as needed
   c. Select and use hand files
   d. Identify and use hand reamers
   e. Correctly identify and use hand taps as required
   f. Follow tapping procedures to produce internal threads
   g. Use thread-cutting dies to produce external threads
   h. Operate bench and pedestal grinders safely
3. Operate Power Saws
   a. Use reciprocating and horizontal band cutoff machines
   b. Prepare and use the vertical band saw
4. Operate Drill Presses
   a. Describe the different types of drill presses found in the machine shop
   b. Describe and use standard drilling tools
   c. Setup the drill presses for drilling, countersinking, counterboring, and reaming operations
5. Operate Vertical Milling Machines
   a. Demonstrate the use of all controls on the vertical milling machine
   b. Align the vertical milling machine head
   c. Select, align and use workholding devices
   d. Select milling tool holders
   e. Select milling cutters
   f. Perform all standard vertical milling operations
6. Operate Metal Cutting Lathes
   a. Demonstrate the use of all controls on the engine lathe
   b. Discuss standard tools and toolholders for the lathe
   c. Face and center drill parts correctly

d. Drill, ream and bore on the lathe
e. Make all calculations, lathe adjustments and settings to machine sixty degree external threads
f. Use HSS cutting tools
g. Use carbide cutting tools

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. follows a schedule to complete assigned tasks on time
2. follows a schedule to maximize laboratory resources
3. complete a stock request form for required material

B. ***Interpersonal:*** *Works with others*
1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested

C. ***Information:*** *Acquires and uses information*
1. read and interpret blueprints
2. organize and apply theories of machine tool operation
3. perform basic semi-precision and precision layout as necessary

D. ***Systems:*** *Understands complex inter-relationships*
1. demonstrate knowledge of the following systems:
   a. organization of personnel and facilities on the shop floor
   b. systematic approach to the metal removal process
   c. dimensioning and measurement systems
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards

E. ***Technology:*** *Works with a variety of technologies*
1. chooses procedure, tools and equipment required to produce a part

2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards

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. read/studies textbook
b. studies student laboratory manual
c. interprets blueprints and technical drawings
d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

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

a. outline the steps necessary to produce a simple machine part
b. maintain a lecture notebook
c. submit written responses to chapter question assignments

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

a. determines optimum machining speeds, feeds, and depth of cut
b. interconverts fractions to decimal expressions
c. keeps a running computation of individual grade
d. calculate tap drill size

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. assimilate classroom instruction
b. interpret and assimilate video instruction
c. observe and assimilate laboratory demonstrations
d. seek and receive individualized instruction in the laboratory
e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics

5. ***Speaking:*** *Organizes ideas and communicates orally*

a. participates in classroom discussions
b. organize ideas and communicate specific questions to the instructor
c. verbally affirms understanding of a concept, procedure, or required skill
d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the laboratory
e. plan and deliver a 10-15 minute oral presentation on an assigned machine-related topic

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. decides upon a job process plan to produce a part to specifications, given constraints of available time, equipment and other resources
   b. prioritizes activities for effective use of time
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. troubleshoots machining processes and equipment
   d. recognize problems in machining and selects appropriate corrective or preventive action
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. visualize objects in three dimensions from engineering drawings
   b. visualize process during instructor lecture
   c. visualize the relative motions between tool and workpiece to generate desired features in raw stock in order to plan machine setups and sequence of machining operations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. understand that practice will improve skill
   b. asks questions or seeks help when uncertain about new skills or knowledge
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. applies knowledge of principles of machining to troubleshoot process problems
   b. applies knowledge of machining process to develop a logical, sequential process plan
   c. applies knowledge of workpiece machinability, cutter characteristics and machine tool characteristics to adjust speeds and feeds

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. displays promptness and preparation for the day's work
   b. plans work to use time efficiently
   c. accepts responsibility for mistakes, and takes corrective and preventive actions
   d. takes initiative when needed to gain resources or assistance to complete assignments
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. takes pride in work through positive reinforcement

b. sees self as a valued member of the group through continued contributions toward common goals

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual gradebook)
   c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers

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

MAST

COURSE SYLLABUS

DRAFTING PRINCIPLES

MAST PROGRAM
COURSE SYLLABUS
DRAFTING PRINCIPLES

Lecture hours/week: 2 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

Students will be assigned basic exercises in lettering, use of instruments, technical sketching, geometric construction, orthographic projection, auxiliary views and dimensioning. Working drawings will be made.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Technical Drawing, Spencer, Giesecke, Mitchell, Hill
Workbook: Technical Drawing Problems, Spencer, Giesecke, Mitchell, Hill

Materials:
Drafting Kit No. 1 or the equivalent:
- 10" Triangles:
  - 1 - 45°
  - 1- 30°/60°
- Engineer's Scale
- Metric Scale
- Ames Lettering Guide
- Eraser Holder with erasers
- Drafting Dots
- Circle Template (Combination Imperial and Metric)
- Sandpaper Pointer
- Erasing Shield
- Bow Compass
- Dusting Brush
- Lead Pointer
- Irregular Curve
- Mechanical Pencils with refills:
  - .5mm
  - .7mm
  - .9mm
- Lead Holder - 2mm
- Leads:
  - .5mm - HB
  - .7mm - H, HB
  - .9mm - HB

2mm 4H, H, F
Hard Carrying Case
8½" x 11" vellum (10 sheets)

Additional items not included in kit:
4 - 17 x 22 (C size) vellum
1 - Preprinted 22 x 34 (D size) vellum

METHODS OF INSTRUCTION:

Lecture: Classroom presentations will include lecture, video and demonstrations. Computer aided instruction may be used.

Laboratory: Laboratory will be a "hands-on" drawing process using appropriate tools and media.

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 safety regulations as stated in the class policies

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Course	---	
Required Materials and Tests	Handout	
Class Policies and Safety Concerns	Handout	
Function of Drafting in Design and Production	1	
Drafting Instruments, Material and Equipment	2	
Lettering	3	
Quiz	---	
Alphabet of Lines	2	
Types of Pencils and Leads	1	
Scales - Engineering and Metric	2	
Quiz	---	
Geometric Constructions	4	
Angle Measurements	4	
Theory of Third Angle Orthographic Projection	6	
Theory of First Angle Orthographic		

Projection	6
Arrangement of Views	6
Common Dimensions Between Views	6/11
Quiz	---
Function of Sectional Views	7
Cutting Planes	7
Conventional Representations	7
Classifications of Sections	7
Quiz	---
Dimensioning Concepts	11
Dimensioning Techniques	11
Selection and Placement of Dimensions	11
Metric Dimensioning	11
Final Exam	---
Total Lecture Hours	**24**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Using Drafting Instruments, Materials and Equipment	2
Applying Lettering	2
Delineating Alphabet of Lines	2
Selecting and Using Pencils and Leads	1
Using Scales	2
Developing Geometric Constructions	12
Using Angle Measurement	1
Using Third Angle Orthographic Projection	6
Using First Angle Orthographic Projection	6
Arranging Views and Common Dimensions	2
Creating Sectional Planes	2
Applying Cutting Planes	2
Determine and Use Conventional Representations	1
Using Classifications of Sections	1
Applying Dimensioning	4
Applying Metric Dimensioning	1
Final Exam	1
Total Lab Hours	**48**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

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

A. **PERFORM DRAFTING TASKS.**

1. Demonstrate Traditional Mechanical Drafting Skills
   a. Form freehand vertical Gothic upper-case letters and numerals of correct shape and space
   b. Execute the alphabet of lines correctly, producing dense black lines of uniform thickness and spacing
   c. Demonstrate proficiency with the engineers and metric scales

d. Execute geometric constructions with no mistakes in tangent points, line quality or layout work
e. Accurately draw the missing view or line in a multiview drawing
f. Make or complete a sectional instrument drawing, given one or more views
g. Develop satisfactory working drawings of simple machine components to include all necessary views and dimensions for complete shape and size description of detail parts
h. Discuss the differences in standard engineering drawings and tool drawings

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. follows a schedule to complete assigned tasks on time
2. determine the appropriate media and instruments to complete assignments
3. provide a self-evaluation of performance based on the time and quality of work

B. Interpersonal: Works with others
1. complete assigned responsibilities within the course serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce drawings to acceptable levels of quality as required
4. works well with all members of the class

C. Information: Acquires and uses information
1. read and interpret text and handouts
2. organize and apply theories of drafting and design
3. apply lecture concepts to lab techniques

D. Systems: Understands complex inter-relationships
1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities in the drafting lab
   c. systematic approach to the drafting and design process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance
   a. during the drawing process
   b. making adjustments to individual laboratory work schedules

c. while constantly evaluating the quality of work to achieve acceptable standards
d. though maintaining a record of evaluations
e. to meet individual goals

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

1. chooses procedure, tools and equipment required to produce a drawing
2. applies appropriate procedures and uses appropriate tools and equipment to produce a drawing to acceptable standards
3. maintains and troubleshoots equipment and tools
   a. applies appropriate preventative maintenance
   b. reports all malfunctions of equipment to supervisor/instructor
   c. performs clean-up assignments of lab

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. studies student laboratory manual and text
   b. interprets blueprints and technical drawings
   c. reads/studies concepts in textbook
   d. follows a daily laboratory schedule to maintain appropriate time-line to meet scheduled deadlines
   e. interprets concepts in lab manual drawings and texts to develop accurate drawings

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outlines the steps necessary to produce a simple drawing
   b. sketches object to produce a final drawing
   c. maintains a schedule of assignments and deadlines (these may take the form of a chart, graph, etc.)
   d. maintains a lecture notebook
   e. submits written responses to chapter question assignments
   f. completes all written assignments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. bisects lines, circles, arcs and angles
   b. divides objects into equal parts
   c. applies tolerances
   d. applies and verify dimensions
   e. uses fraction and decimal values
   f. applies principles of trigonometry and geometry to solve angle calculations, tangencies and to define points

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. assimilates concepts presented by lecture, video or any multimedia methods
b. observes laboratory demonstrations for technique and safety instructions
c. seeks and receive individualized instruction in the laboratory
d. actively listens and participates in discussions and question/answer sessions

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organizes ideas and communicates specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the efficient and safe completion of assignments

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

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. prioritizes goals
   c. identifies specific actions required to accomplish personal goals
   d. allows for flexibility in meeting goals as circumstances change
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. assimilates process during instructor demonstrations
   c. interprets technical drawings
   d. interprets technical illustrations and symbols
   e. interprets and applies geometric construction concepts
   f. completes missing orthographic views
   g. creates multiview projections from pictorial drawings
   h. identifies missing lines in multiview drawings
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of the basic skills and techniques
   b. uses these sequential skills to support mastery of new skills
   c. consistently applies the sequential nature of acquired skills to the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice will improve the skill of the technician

b. understands that the quality of the product is a function of time spent and the attitude and skill of the technician

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. attends class as scheduled and is well prepared for the day's work
   b. completes assignments independently and on time
   c. works well within a team while completing individual assignments
   d. plans and organizes so time may be used wisely
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assists classmates in improving technical skills
   b. assists students with special needs as a peer mentor
   c. shares laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. performs in-process quality checks on technical drawings
   b. maintains a record of academic achievement (individual gradebook)
   c. maintains a schedule of deadlines, due dates, and other important dates (calendar)
   d. adjusts calendar to accommodate unexpected circumstances
   e. accepts the responsibility for self management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accepts the responsibility for own actions
   b. exhibits personal honesty at all times
   c. accepts the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understands the consequences of unethical behaviors

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

MAST

COURSE SYLLABUS

MACHINE TOOL PRACTICES II

Prerequisite: MACHINE TOOL PRACTICES I

MAST PROGRAM
COURSE SYLLABUS
MACHINE TOOL PRACTICES II

Lecture hours/week: 3 **Lab hours/week: 9** **Credit hours: 6**

COURSE DESCRIPTION:

This course is designed to develop additional machining skills for those students who have the basic skills that were developed in Machine Tool Practices I.

The student will work from more complex engineering drawings and use the engine lathe and milling machines to produce parts that will assemble into a functioning machine. Precision work and the control of surface finishes will be stressed. The engine lathe will be used to turn, taper, thread, bore, ream and knurl several parts. The milling machine will be used to cut keyways, mill precise angles and bore holes. The safe operation and maintenance of the machine shop will also be an important objective.

PREREQUISITES: Machine Tool Practices I

REQUIRED COURSE MATERIALS:

Textbook: Machine Tool Practices, Kibbe, Neely, and Meyer, Wiley Pub., 4th Ed.
Lab Manual: Machine Tool Practices II, Raborn, TSTC Pub., 4th Ed.

Student Tool List/Qty. Req'd: The same hand tools required in Machine Tool Practices I are also required for Machine Tool Practices II.

METHODS 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. perform on written, oral, or practical examinations
4. 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 the Course	---	1
Safety in the Machine Shop	5	1
Gages	88	1
Lathe Parts	414	1
Lathe Accessories	394	1
Cutting Speeds and Feeds	270	1
Aligning Centers	440	1
Machining Between Centers	428	1
Knurling and Grooving	452	1
QUIZ I (over the above units)	---	1
Tapers	477	2
Threads	457	3
Using Chucks	408	1
Drilling and Boring	443	1
Milling Machines	502	1
QUIZ 2 (over the above units)	---	1
Milling Cutters	507	1
Cutting Speeds	522	1
Milling Operations	526	1
Indexing	592	2
Gears	607	1
Gear Cutting	611	1
Assembly of Jig Saw	---	3
QUIZ 3 (over the above units)	---	1
Oral Presentations*	---	6
	Total Lecture Hours	**36**

**(15-20 minute student presentations on assigned machine-related topics. These topics could include future trends or special concerns of the machine tool industry.)*

LAB OUTLINE:

Lab Topics	Contact Hrs.
Shop orientation and safety	1
Precision layout	4
Precision measuring with gage blocks and sine bar	8
Lathe work	27
Vertical milling machine work	18
Horizontal milling machine	6

Bench work		27
Assembly of machined parts		6
Testing of completed machine		6
Leaving the shop in order		5
	Total Lab Hours	**108**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

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

A. PRACTICE SAFETY

1. Follow Safe Operating Procedures for Hand and Machine Tools
   a. Identify and understand lathe operating procedures
   b. Demonstrate safe lathe operation
   c. Identify and understand milling machine operating procedures
   d. Demonstrate safe milling machine operation

B. APPLY MATHEMATICAL CONCEPTS

1. Perform Basic Trigonometric Functions
   a. Solve for unknown angles
   b. Calculate bolt hole patterns
2. Calculate Speeds and Feeds for Machining
   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut
3. Locate Machining Points from a Datum Point
   a. Identify points using the absolute dimensioning system
   b. Identify points using the incremental dimensioning system
4. Perform Calculations for Sine Bar and Sine Plate
   a. Calculate gage block build up for 5" sine bar
5. Calculate for Direct, Simple, and Angular Indexing
   a. Calculate for direct indexing
   b. Calculate for simple indexing (plain)
   c. Calculate for angular indexing
   d. Use Machinery's Handbook for calculations
6. Perform Calculations Necessary for Turning Tapers
   a. Calculate tail stock offset
   b. Determine unknowns (e.g., small and/or large diameters) for taper turning
7. Calculate Depth of Cut on Round Surfaces
   a. Calculate depth of cut for flats to be machined on cylindrical pieces
   b. Calculate depth of cut for keyways which are machined on cylindrical pieces

C. PERFORM CONVENTIONAL MACHINING OPERATIONS

1. Operate Vertical Milling Machines
   a. Demonstrate the use of all controls on the vertical milling machine
   b. Align the vertical milling machine head
   c. Select, align and use workholding devices
   d. Select milling tool holders

e. Select milling cutters
f. Perform all standard vertical milling operations
g. Bore a hole using the offset boring head
h. Machine angles using sine bar and gage blocks
i. Setup and use special vertical mill fixtures
j. Setup and machine dovetails
k. Machine keyways

2. Operate Horizontal Milling Machines
   a. Discuss the difference in plain and universal horizontal milling machines
   b. Discuss the types of spindles, arbors and adaptors used on the horizontal milling machine
   c. List several common work holding methods
   d. Use plain milling cutters
   e. Use side milling cutters
   f. Use face milling cutters

3. Operate Metal Cutting Lathes
   a. Demonstrate the use of all controls on the engine lathe
   b. Discuss standard tools and toolholders for the lathe
   c. Face and center drill parts correctly
   d. Drill, ream and bore on the lathe
   e. Turn between centers
   f. Discuss alignment of lathe centers
   g. Make all calculations, lathe adjustments and settings to machine UNF and UNC series threads
   h. Discuss thread fit classifications
   i. Describe the common tapers used in the machine shop
   j. Discuss taper cutting and calculations for the lathe
   k. Use HSS cutting tools
   l. Use carbide cutting tools

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. follows a schedule to complete assigned tasks on time
2. follows a schedule to maximize laboratory resources
3. complete a stock request form for required material

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

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested

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

1. read and interpret blueprints
2. organize and apply theories of machine tool operation
3. perform basic semi-precision and precision layout as necessary

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

1. demonstrate knowledge of the following systems:
   a. organization of personnel and facilities on the shop floor
   b. systematic approach to the metal removal process
   c. dimensioning and measurement systems
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards

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

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards

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. read/studies textbook
   b. studies student laboratory manual
   c. interprets blueprints and technical drawings
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. prepare job process for lathe and mill assignments

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

a. determines optimum machining speeds, feeds, and depth of cut
b. interconverts fractions to decimal expressions
c. keeps a running computation of individual grade
d. calculate gage block buildup
e. calculate for turning tapers
f. calculate for indexing problems

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe and assimilate laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
   e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the laboratory
   e. plan and deliver a 15-20 minute oral presentation on an assigned machine-related topic

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. decides upon a job process plan to produce a part to specifications, given constraints of available time, equipment and other resources
   b. prioritizes activities for effective use of time

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. troubleshoots machining processes and equipment
   d. recognize problems in machining and selects appropriate corrective or preventive action

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. visualize objects in three dimensions from engineering drawings
   b. visualize process during instructor lecture
   c. visualize the relative motions between tool and workpiece to generate desired features in raw stock in order to plan machine setups and sequence of machining operations

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. understand that practice will improve skill
   b. asks questions or seeks help when uncertain about new skills or knowledge
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. applies knowledge of principles of machining to troubleshoot process problems
   b. applies knowledge of machining process to develop a logical, sequential process plan
   c. applies knowledge of workpiece machinability, cutter characteristics and machine tool characteristics to adjust speeds and feeds

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. displays promptness and preparation for the day's work
   b. plans work to use time efficiently
   c. accepts responsibility for mistakes, and takes corrective and preventive actions
   d. takes initiative when needed to gain resources or assistance to complete assignments
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. takes pride in work through positive reinforcement
   b. sees self as a valued member of the group through continued contributions toward common goals
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed., McGraw Hill Publishers

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

MAST

COURSE SYLLABUS

APPLICATION SOFTWARE

MAST PROGRAM
COURSE SYLLABUS
APPLICATION SOFTWARE

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 3**

COURSE DESCRIPTION:

This course covers introductory computer concepts combined with an emphasis on the more predominate computer software including, but not limited to DOS, word processing, electronic spreadsheets, and data bases thus providing non-majors with computer literacy and hands-on experience.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Microsoft Office Professional for Windows (Illustrated); by Halvorson, Swanson, Reding, Beskeen, and Johnson. Latest edition.

Lab Manual: **None**

Supplies/Quantity Required:

2 - High density disks (3 ½")
6 - Scantron test forms

METHODS OF INSTRUCTION:

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

Laboratory: Laboratory will be a "hands-on" application of computer software.

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 computer skills 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

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
DOS Commands		2
Review & Test - DOS Commands		1
Microsoft Windows 3.1		2
a. Getting started with Windows 3.1		
b. Creating and managing files		
Review & Test - Microsoft Windows 3.1		1
Microsoft Word 6.0		1
a. Getting started with Microsoft Word 6.0		
b. Creating and editing a document		
c. Formatting a document		
d. Arranging text and graphics		
Review & Test - Microsoft Word 6.0		1
Microsoft Excel 5.0		1
a. Getting started with Microsoft Excel 5.0		
b. Creating a worksheet		
c. Modifying a worksheet		
d. Working with charts		
e. Integrating Word and Excel		
Review & Test - Microsoft Excel 5.0		1
Microsoft Access 2.0		1
a. Getting started with Microsoft Access 2.0		
b. Creating a database		
c. Manipulating data		
d. Creating forms and reports		
Review & Test - Access 2.0 for Windows		1
	Total Lecture Hours	**12**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Work with DOS Tutor (Sections 2, 4, 5, 6, and 7)	12
Microsoft Windows 3.1 (Units 1 and 2)	10
Microsoft Word 6.0 (Units 1, 2, 3, and 4)	10
Microsoft Excel 5.0 (Units 1, 2, 3, and 4)	8
Microsoft Access 2.0 (Units 1, 2, 3, and 4)	8
Total Lab Hours	**48**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

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

A. USE COMPUTERS

1. Use Computer Operating Systems
   a. Use basic computer terminology appropriately and accurately
   b. Boot the computer and recognize the basic components of DOS
   c. Use DOS to perform file management
   d. Use DOS to perform directory management

e. Install software packages on a PC

2. Use Computer Inquiry Systems
   a. Log in to a multi-user system
   b. Access system for needed information
   c. Print reports as necessary
3. Use Various Computer Applications
   a. Load word processor, create, save, edit, and print a document
   b. Load spreadsheet, create, save, retrieve, erase, edit, and print a worksheet
   c. Load database programs, create, edit, delete, and print records in a database file

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. follows a schedule to complete assigned tasks on time

B. ***Interpersonal:*** *Works with others*
   1. provide individual assistance/direction to peers as requested
   2. works well with all members of the class

C. ***Information:*** *Acquires and uses information*
   1. read and interpret textbooks

D. *Systems: Understands complex inter-relationships*
   1. demonstrate knowledge of the following systems:
      a. laboratory organization structure: physical and social
      b. systematic organization of training materials
   2. monitors and corrects performance during
      a. operation of computer hardware and software
      b. adjustments of individual laboratory work schedule
      c. constantly evaluating the quality of work to achieve acceptable standards
      d. maintains record of evaluations and sets individual goals

E. *Technology: Works with a variety of technologies*
   1. chooses procedure to successfully complete assignments

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. studies student laboratory manual
b. read/studies textbook
c. follow a daily laboratory schedule to maintain appropriate time-line

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

a. maintain a lecture notebook
b. submit written responses to chapter question assignments
c. complete all written assignments

3. Listening: Receives, attends to, interprets, and responds to verbal messages and other cues

a. assimilate classroom instruction
b. interpret and assimilate video instruction
c. observe classroom demonstrations
d. seek and receive individualized instruction in the laboratory

4. Speaking: Organizes ideas and communicates orally

a. participates in classroom discussions
b. organize ideas and communicate specific questions to the instructor
c. verbally affirms understanding of a concept, procedure, or required skill

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. identifies personal goals
b. identifies actions required to accomplish personal goals

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

a. makes daily accommodations to stay on schedule
b. seeks additional instruction/clarification for assignment completion
c. balances social and academic life/responsibilities
d. accepts responsibility

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

a. interprets technical manuals
b. interprets technical illustrations and symbols
c. understands both written and verbal instructions
d. assimilates process during instructor demonstrations

4. Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills

a. demonstrate mastery of the basic skills and techniques
b. use these sequential skills to support mastery of new skills

c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator

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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving computer skills
   b. assist students with special needs as a peer mentor

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process checks of work
   b. maintain a record of academic achievement (individual gradebook)
   c. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

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

MAST

COURSE SYLLABUS

INTRODUCTION TO PLASTICS

MAST PROGRAM
COURSE SYLLABUS
INTRODUCTION TO PLASTICS

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

COURSE DESCRIPTION:

This is a survey course designed to introduce the student to the field of plastics. This overview will include both thermoplastic and thermoset materials along with the major processing methods being utilized by industry today.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Plastics: Materials and Processing, by Strong. Published by Prentice Hall. Latest edition.

Lab Manual: **NONE**

Hand Tools/Quantity Required: **NONE**

METHODS OF INSTRUCTION:

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

Laboratory: Laboratory will consist of "hands on" activities which will enable the student to learn the selection and preparation of raw materials, machining functions, mold set up, and the use of auxiliary equipment associated with injection molding.

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 Plastics	Chapter 1	2
Forms of Plastic	Chapter 5	3
Ingredients of Plastics	Chapter 6	3
Thermoplastics and their Properties	Chapter 7	5
Thermosetting Plastics	Chapter 8	4
Molding Processes	Chapter 10	3
Extrusion Processes	Chapter 11	2
Thermoforming Processes	Chapter 15	3
	Total Lecture Hours	**24**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Identification of Plastic Materials	3
Introduction to Thermoplastic Processing	3
Introduction to Thermoset Processing	3
Introduction to Molding Equipment	6
Introduction to Molding Processes	3
Introduction to Extrusion Molding	3
Introduction to Thermoforming	3
Total Lab Hours	**24**

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. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Interpret safety manual directives
   d. Comply with established company safety practices
2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when handling molds or other heavy materials (e.g., eye bolts, slings, cables)
3. Debur Mold Bases to Help Avoid Cuts
   a. Chamfer outside edges of mold bases
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Keep machine and hand tools clean at all times

c. Put tools away when not in use
d. Keep aisles clear of equipment and materials

B. SELECT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
   a. Discuss classification system for plastics
   b. Discuss general characteristics for various plastic materials
2. Identify Types of Plastic Materials
   a. Discuss advantages of using plastics
   b. Discuss classifications of plastics
   c. Discuss forms available forms (e.g., resins, coatings, adhesives, laminates, compounds)
   d. Discuss properties
3. Identify Plastic Molding Processes
   a. Describe the blow molding process
   b. Describe the vacuum forming process
   c. Describe the injection molding process
   d. Describe the reaction injection molding process
   e. Describe the extrusion molding process
   f. Describe the compression molding process
   g. Describe the transfer molding process
   h. Describe the rotational molding process
   i. Discuss the advantages of using composites
   j. Describe the composite molding methods

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. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of processing
3. provide a self-evaluation of performance based on the time and quality of work

B. *Interpersonal: Works with others*
   1. complete assigned responsibilities within the shop floor serving as a member of the team
   2. provide individual assistance/direction to peers as requested
   3. produce molded parts to acceptable levels of quality as required
   4. works well with all members of the class

C. *Information: Acquires and uses information*
   1. read and interpret blueprints
   2. organize and apply theories of plastic molding equipment operation

D. *Systems: Understands complex inter-relationships*
   1. demonstrate knowledge of the following systems:
      a. laboratory organization structure: physical and social
      b. organization of personnel and facilities on the shop floor
      c. systematic approach to the plastic molding process
      d. systematic organization of training materials
   2. monitors and corrects performance during
      a. the molding process
      b. adjustments of individual laboratory work schedule
      c. constantly evaluating the quality of work to achieve acceptable standards
      d. maintains record of evaluations and sets individual goals

E. *Technology: Works with a variety of technologies*
   1. chooses procedure, tools and equipment required to produce a part
   2. applies appropriate procedures and uses appropriate tools and equipment to produce a molded part to acceptable standards
   3. maintains and troubleshoots equipment
      a. applies appropriate preventative maintenance
      b. when operating machines
      c. reports all malfunctions of equipment to supervisor/instructor
      d. perform clean-up assignments of machine and shop floor at the end of the laboratory

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. studies student laboratory manual
      b. interprets molding machine manuals
      c. read/studies textbook
      d. follow a daily laboratory schedule to maintain appropriate time-line and product completion
   2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. outline the steps necessary to produce a molded plastic part

b. maintain a lecture notebook
c. submit written responses to chapter question assignments
d. complete all written assignments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum time and temperature settings for various plastic polymers
   b. calculates "value added to the part"
   c. adjusts timers and heaters to maintain a quality part

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
   b. identifies actions required to accomplish personal goals

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills

c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the technician
   c. understands the relationship between different plastic materials and the processing variables and adjusts molding parameters 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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on molded parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions

b. exhibit personal honesty at all times
c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

Machine Tool Advanced Skills Technology Program

MAST

COURSE SYLLABUS

SURVEY OF WELDING PROCESSES AND APPLICATIONS

MAST PROGRAM
COURSE SYLLABUS
SURVEY OF WELDING PROCESSES AND APPLICATIONS

Lecture hours/week: 3 **Lab hours/week: 3** **Credit hours: 4**

COURSE DESCRIPTION:

This course is a survey of shielded metal arc, gas tungsten arc, gas metal arc, flux cored arc, and submerged arc welding processes. Metal weldability and weld symbols are considered. Process safety, electrode selection, and process parameters are emphasized. Hard surfacing, using shielded metal arc and oxyacetylene processes and techniques are studied.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Oxy-Acetylene Handbook, by Linde, Union Carbide Publisher, Latest Edition
New Lessons in Arc Welding, by Lincoln Electric, Lincoln Electric Publisher, Latest Edition

Lab Manual: None Required

Student Tool List	Qty. Req'd.
Oxy-acetylene cutting and welding goggles (mono) with #5 filter lens and one clear plastic lens	1 pair
Friction lighter	1
Wire brush 1" wide with long handle	1
Soap stone	2 pieces
Welder's cap	1
Welding gloves, long gauntlet	1 pair
Chipping hammer	1
Safety glasses	1 pair
Slip joint pliers	1 pair

METHODS OF INSTRUCTION:

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

Laboratory: Hands on laboratory activities to enable the students to learn the various aspects of the welding 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. perform on written, oral, or practical examinations
4. 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 the course		1
Introduction to oxy-acetylene fusion	1	1
Oxy-acetylene welding and cutting	9	2
Introduction to mechanical and physical properties	77	1
Non-fusion welding		1
Introduction to the oxy-acetylene cutting processes		1
Test #1		1
The shielded metal arc welding process	1-7	1
Running a good quality bead in the flat position	1-21	1
Introduction to shielded metal arc welding electrodes	3-3	2
Shielded metal arc power sources	2-3	1
Test #2		1
Weld joints, weld types and weld positions	1-54	2
Introduction to fillet welds	1-56	1
Test #3		1
Introduction to gas metal arc welding and flux core arc welding	7-37	2
Short circuiting metal transfer		1
Test #4		1
Power sources for GMAW and FCAW		1
SMAW and FCAW filler metal transfer modes		1
Test #5		1
Shielding gases used with the GMAW process	7-37	1
Shielding gases used with the FCAW process		1
Test #6		1

Introduction to gas tungsten arc welding		2
Power sources for GTAW		1
GTAW electrodes		1
Test #7		1
Introduction to submerged arc welding and techniques	7-69	1
Submerged arc welding processes		1
Test #8		1
	Total Lecture Hours	**36**

LAB OUTLINE:

	Lab Topics	Contact Hrs.
1	**The Oxy-Acetylene Welding and Cutting Process**	9
	Demonstration of setting up and break down of equipment	
	A. Welding beads on plate	
	(1) Flat position	
	(2) Without and with filler	
	B. Square butt joints	
	(1) Flat and vertical position	
	(2) With filler material	
	C. Brazing beads on plate	
	(1) Flat position	
	(2) With filler material	
	D. Brazing square butt joint	
	(1) Flat and vertical position	
	(2) With filler	
	E. Oxy-acetylene cutting	
	(1) Cutting to a straight line	
2	**The Shielded Metal Arc Welding Process (SMAW)**	9
	A. Welding beads on plate	
	(1) E6010, E6011 and/or E7018 dependent on availability	
	(2) Flat, horizontal and vertical	
	B. Welding tee joint	
	(1) E6010, E6011 and/or E7018 dependent on availability	
	(2) Flat, horizontal and vertical	
3	**The Gas Metal Arc Welding and Flux Core Welding Processes (GMAW)**	6
	A. Set up 3 machines each process	
	B. Welding beads on plate, both processes	
	(1) Have hands on with observers at each station	
	C. Demonstration of GMAW spot welder	
4	**The Gas Tungsten Arc Welding Process (GTAW)**	6
	A. Set up machines for welding steel and aluminum (2 or 3 each)	
	B. Welding beads on plate steel	
	(1) Have hands on with observers	
	C. Welding bead on plate aluminum	

(2) Have hands on with observers

5	**The Submerged Arc Welding Process**	6
	A. Demonstrate beads on plate	
	B. Demonstrate running beads roll position	
	C. Let students have hands on and observation	
	Total Lab Hours	36

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

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

A. PRACTICE SAFETY

1. Use Protective Equipment
   a. Wear protective safety clothing as required when welding
2. Follow Safe Operating Procedures for Welding/Cutting Machines
   a. Identify and understand safe welding procedures
   b. Demonstrate safe welding procedures

B. PERFORM WELDING OPERATIONS

1. Weld With Shielded Metal Arc Welding (SMAW) Process
   a. Identify factors for welding electrode selection
   b. Adjust welding amperage setting for each application
   c. Demonstrate proper use of safety equipment
   d. Weld beads on plate (flat and horizontal)
   e. Weld tee joints (flat and horizontal)
   f. Identify weld inspection factors and techniques
2. Weld/Cut With Oxy-acetylene
   a. Setup and break down the oxy-acetylene welding/cutting station
   b. Properly adjust oxy-acetylene regulators
   c. Identify factors that determine torch welding and cutting tip selection
   d. Demonstrate routine torch maintenance procedures
   e. Weld beads on plate (with and without filler) in the flat and horizontal positions
   f. Weld square groove butt joints in the flat and horizontal positions
   g. Braze weld beads on plate in the flat position
   h. Make square cuts to a straight line with the cutting torch
   i. Demonstrate proper use of safety equipment
3. Weld With Gas Tungsten Arc Welding (GTAW) (Heliarc)
   a. Set up GTAW welder for welding steel
   b. Set up GTAW welder for welding aluminum
   c. Weld beads on plate (steel) with appropriate filler rod in the flat position
   d. Weld beads on plate (aluminum) with appropriate filler rod in the flat position
   e. Weld lap joints in the horizontal position on steel plate
   f. Weld lap joints in the horizontal position on aluminum plate
4. Weld With Gas Metal Arc Welding (GMAW)/(MIG)
   a. Set up machine for gas metal arc welding

b. Set up machine for flux cored arc welding
c. Weld beads on plate with gas metal arc welding system in the flat position
d. Weld beads on plate with flux cored welding system in the flat position
e. Weld lap joints on steel plate with the gas metal arc welding system in the horizontal position
f. Weld lap joints on steel plate with the flux cored arc welding system in the horizontal position

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. follows a schedule to complete assigned tasks on time
2. follows a schedule to maximize laboratory resources
3. complete a tool crib request form for required materials and supplies

B. Interpersonal: Works with others
1. complete assigned responsibilities within the welding lab serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. works well with all members of the class

C. Information: Acquires and uses information
1. read and interpret weld symbols
2. organize and apply theories of welding and cutting

D. Systems: Understands complex inter-relationships
1. demonstrate knowledge of the following systems:
   a. organization of personnel and facilities on the shop floor
   b. systematic approach to the cutting and welding processes
   c. welding rod classification and match to various metals
   d. systematic organization of training materials
2. monitors and corrects performance during
   a. the welding process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards

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

1. chooses procedure, tools and equipment required to perform the welding process
2. applies appropriate procedures and uses appropriate tools and equipment to produce a weld to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when using equipment
   c. reports all malfunctions of equipment to supervisor/instructor

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. read/studies textbook
   b. studies student laboratory manual
   c. interprets welding symbols
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to set up, properly adjust and weld/cut using different types of welding equipment
   b. maintain a lecture notebook
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. keeps a running computation of individual grade
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe and assimilate laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
   e. practices active listening by affirming understanding of verbal instructions, asking questions for clarification and probing for specifics
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicate with peers, instructors and supervisors to ensure the smooth and safe operation of the laboratory

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. analyzes requirements and makes decisions to select appropriate welding process, equipment, materials, fixturing, and protective equipment
   b. prioritizes activities for effective use of time
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. troubleshoots welding problems and makes process adjustments to correct
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. visualize process during instructor lecture
   b. visualize the relative motions between welding rod and workpiece to generate desired weld patterns and weld strength as required
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. understand that practice will improve skill
   b. asks questions or seeks help when uncertain about new skills or knowledge
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. applies knowledge of material characteristics, job requirements, and welding processes to perform assignments
   b. applies knowledge of material characteristics, job requirements, and welding processes to troubleshoot and/or imporve the welding process

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. displays promptness and preparation for the day's work
   b. plans work to use time efficiently
   c. accepts responsibility for mistakes, and takes corrective and preventive actions
   d. takes initiative when needed to gain resources or assistance to complete assignments
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. takes pride in work through positive reinforcement
   b. sees self as a valued member of the group through continued contributions toward common goals

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. share laboratory resources (welding machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on weldments
   b. maintain a record of academic achievement (individual grade book)
   c. accept responsibility for mistakes and infractions, and take steps to resolve or eliminate them
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Welding Technology Today, Principles and Practices. Stinchcomb, Craig;: Prentice Hall Inc., New Jersey 1989
3. Welder Handbook. W-100 E-1 Corp., Publication #51077, Nov., 1995
4. Hobart Audio - Visual Training Program
5. Miller Audio - Visual Training Program

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

MAST

COURSE SYLLABUS

SAFETY AND ACCIDENT PREVENTION

MAST PROGRAM
COURSE SYLLABUS
SAFETY AND ACCIDENT PREVENTION

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

COURSE DESCRIPTION:

A course designed to enable the student to recognize hazards and potential hazards which may occur in the workplace and to take corrective action. The course may be directed toward a specific technology as required. Federal safety requirements under the OSHA law will be emphasized. General supervisor safety training course for all technologies.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Supervisor's Safety Manual, National Safety Council, 8th Edition
Lab Manual: **NONE**

Hand Tools/Quantity Required:
Notebook paper
Notebook
Pencils or pens

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, demonstrations, and the following training materials and visual aids (OSH Film Library):
"The Convincer" - 45 min. color slide
"Safety and the Supervisor - 16 mm - color film
"All About OSHA" - 16 mm - color film
"Search for Safety" - 16 mm - color film
"In Search of the Facts" - 16 mm - color film
"Color of Danger" - 16 mm - color film
"Six Ways to Lift" - 16 mm - color film
"MGM Grand Hotel Fire" - 16 mm - color film

Laboratory: Laboratory assignments will require students to recognize hazards and potential hazards which may occur in the workplace and to take corrective action.

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. satisfactorily perform on written, oral, and practical examinations
3. explain all the elements of good communication as it relates to safety
4. apply several human relations concepts as a supervisor to ensure safety in the work place
5. discuss the importance of industrial hygiene and noise control
6. correctly fill out an accident investigation report and a safety inspection form
7. discuss and/or demonstrate the use of personal protective equipment
8. apply the principles of and discuss the benefits of machine safeguarding
9. explain and/or demonstrate the use and safe handling of hand and portable power tools
10. discuss safe electrical procedures
11. discuss the basic principles and causes of fire
12. explain the need for safety training of workers
13. satisfactorily perform on outside assignments including writing assignments
14. contribute to class discussions
15. maintain attendance per current policy
16. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction		1
Course content and text		
Attendance and grading		
Testing procedures		
The origin of the safety movement		
The Williams-Steiger Act		
OSHAct applied to technology		
Safety Management		1
Definition of terms		
Areas of responsibility		
The "old" approach to safety performance		
A better approach to safety performance		
Summary of Key Points		
Communications		1
Elements of communication		
Methods of communication		
Effective listening		
Summary of key points		
Human Relations		1
Human relations concepts		
Leadership		
Coping with difficult problems		
Shift work and shift changes		
Stress management		
Alcohol and drug problems		
Employee assistance programs		
Summary of key points		
Employee Safety Training		1

Orientation training
Job instruction training
Other methods of instruction
Job safety analysis
Summary of key points
Employee Improvement 1
Promoting safety among workers
Off-the-job accident problems
Summary of key points
EXAM #1 1
Safety Inspections 1
Formal inspections
Inspection planning and procedures
Inspecting work practices
Inspection reports
Summary of key points
Accident Investigation 1
Accident reporting
Finding causes
Emergency procedures
Effective use of witnesses
Accident investigation reports
Summary of key points
EXAM #2 1
Industrial Hygiene 1
Chemical stresses
Physical stresses
Ergonomic stresses
Biological stresses
Threshold limit values
Standard Operating Procedures (SOP)
Summary of key points
EXAM #3 1
Personal Protective Equipment 1
Controlling hazards
Head protection
Face protection
Eye protection
Ear protection
Respiratory protection
Body protection
Protecting extremities
Summary of key points
EXAM #4 1
Ergonomics 1
What are ergonomic problems?
Understanding ergonomics
Materials movement

Work space and body characteristics
Hand work and use of tools
Whole-body vibration
Video display terminals
Lighting, noise, and heat
Summary of key points
EXAM #5 1
Machine Safeguarding 1
Principles of guarding
Safeguard design
Safeguarding mechanisms
Automation
Maintenance of safeguards
Summary of key points
Hand Tools and Portable Power Tools 1
Safe work practices
Use of hand tools
Portable power tools
Supervisory considerations
Maintenance and repair
Summary of key points
Materials Handling and Storage 1
Materials handling problems
Manual handling methods
Materials handling equipment
Ropes, chains, and slings
Materials storage
Summary of key points
EXAM #6 1
Electrical Safety 1
Myths and misconception about electricity
Electrical fundamentals review
Branch circuits and grounding concepts
Plug and cord connected equipment and extension cords
Branch circuit and equipment testing methods
Ground-fault circuit interrupters
Hazardous locations
Electrical standards most often violated
Inspection guidelines and checklist
Safeguards for portable home electrical appliances
Safety program policy and procedures
Electrical distribution system review
Summary of key points
Fire Safety 1
Basic principles
Causes of fire

Other hazardous materials
Effective housekeeping for fire safety
Fire prevention inspections
Alarms, equipment, and evacuation
Fire protection education
Protective insurance requirements
Summary of key points
EXAM #7 1

Total Lecture Hours 24

LAB OUTLINE:

Lab Topics	Contact Hrs.
Students will research each chapter of the Supervisor's Safety Manual and answer questions which cover the main points of the chapter	16
Students will demonstrate the six steps in proper lifting	4
Students will demonstrate the proper use of powered hand tools	6
Students will demonstrate the use of different types of fire extinguishers	6
Students will explain the importance of inspecting electrical extension cords, plugs and cord-connected equipment	4
Total Lab Hours	**36**

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. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Interpret safety manual directives
   d. Comply with established company safety practices
   e. Complete forms/paperwork as required
2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when necessary
3. Follow Safe Operating Procedures for Hand and Machine Tools
   a. Identify and understand safe machine operating procedures
   b. Demonstrate safe machine operation
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Clean machine/hand tools when work is completed
   c. Put tools away when work is finished
   d. Keep aisles clear of equipment and materials

e. Perform preventative maintenance as required

5. Control Fire Hazards
   a. Handle/store flammable materials appropriately
   b. Use electricity correctly (e.g., defective outlets, frayed cords, "burning" odor)
   c. Prevent spontaneous ignition by practicing proper waste disposal habits
   d. Keep marked aisles clear of equipment and materials
   e. Interpret/display MSDS sheets as required
   f. Identify fire exits and fire-fighting equipment
6. Apply American Red Cross First Aid and CPR Procedures
   a. Notify appropriate personnel of injury
   b. Check and evaluate life-endangering conditions
   c. Determine need for CPR
   d. Apply appropriate first aid techniques
   e. Complete accident report as needed
7. Recommend Hazardous Waste Management Techniques
   a. Define the types of hazards (e.g., chemical, biological, and physical)
   b. Evaluate and determine hazards
   c. Interpret MSDS sheets
   d. Describe the proper collection for a variety of hazardous wastes
   e. Respond to emergencies in the appropriate manner
8. Apply Ergonomic Principles to the Workplace
   a. Define ergonomics
   b. Explain the characteristics and potential impact of ergonomics on design, productivity, and safety
9. Demonstrate Knowledge of State and Federal EPA Regulations
   a. Meet health, safety, and legal requirements with regard to process, product and people

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. follows a schedule to complete assigned tasks on time
2. provide a self-evaluation of performance based on the time and quality of work

B. ***Interpersonal:*** *Works with others*
1. provide individual assistance/direction to peers as requested
2. works well with all members of the class

C. ***Information:*** *Acquires and uses information*
1. studies safety materials and completes assignments
2. makes safety recommendations based on classroom instruction

D. ***Systems:*** *Understands complex inter-relationships*
1. demonstrate knowledge of the following systems
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities in the lab
   c. systematic organization of training materials
2. monitors and corrects performance during
   a. adjustments of individual laboratory work schedule
   b. maintains record of evaluations and sets individual goals

E. ***Technology:*** *Works with a variety of technologies*
1. apply fire safety principles
2. apply hazardous material handling principles
3. apply ergonomic principles to the workplace

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. studies student laboratory manual
   b. read/studies textbook
   c. follow a daily laboratory schedule to maintain appropriate time-line and product completion
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. maintain a lecture notebook
   b. submit written responses to chapter question assignments
   c. complete all written assignments
3. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
4. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the student

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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. assist classmates in improving technical skills
b. assist students with special needs as a peer mentor
c. share laboratory resources (machines, tools and instructor's individual attention)

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. maintain a record of academic achievement (individual grade book)
   b. make accommodations to laboratory schedules due to broken machines/tools
   c. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

OSH216
01/072396

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

MAST

COURSE SYLLABUS

ENGINEERING MATERIALS

MAST PROGRAM
COURSE SYLLABUS
ENGINEERING MATERIALS

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

COURSE DESCRIPTION:

Engineering Materials is the study of materials used in the manufacture of products produced by a variety of manufacturing processes. Topics will include the characteristics and properties of both metallic and nonmetallic materials used in the design of products. Students will conduct tests on materials, collect data and interpreting that data.

PREREQUISITES: **Machine Tool Practices I**
Machine Tool Practices II
College Algebra

REQUIRED COURSE MATERIALS:

Textbook: Practical Metallurgy and Materials of Industry, John Neely, Wiley Pub., 3rd Ed.
Lab Manual: NONE

Tools and Equipment/Quantity Required:

Safety Glasses	1
Scientific Calculator	1

METHODS OF INSTRUCTION:

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

Laboratory: Laboratory will be "hands-on" activities.

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 Topic	Text Reference Page	Contact Hrs.
Extracting Metals from Ores	12-28	
The Manufacture of Steel Products	32-41	
Identification and Selection of Iron & Steels	44-50	
Identification on Nonferrous Metals	52-64	
Identification and Selection of Nonmetallic Materials		
The Mechanical and Physical Properties of Materials	70-86	
Rockwell and Brinell Hardness Testers	92-98	
The Crystalline Structure of Materials	102-123	
Phase Diagrams and the Iron-Carbon Diagram	127-142	
Hardening and Tempering of Carbon Steels	145-151	
Annealing, Normalizing and Stress Relieving	155-163	
I-T Diagrams and Cooling Curves	165-173	
Harden ability of Steels and Tempered Martensite	175-183	
Heat-Treatment Equipment and Procedures	185-206	
Heat Treatment of Nonferrous Metals	207-207	
	Total Lecture Hours	**24**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Using Hardness Testers	6
a) Standard Rockwell Hardness Tester	
b) Superficial Rockwell Tester	
c) Automatic Rockwell Hardness Tester	
d) Shores Tester	
e) Brinell Tester	
f) Vickers Tester	
Microscopic Examination of Specimens	12
Determination of Critical Temperature of Steels	6
Tempering of Hardened Materials	4
Impact Testing	4
Determining the Harden ability of Steels	4
Total Lab Hours	**36**

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. Assume responsibility for the personal safety of oneself and others

b. Develop a personal attitude towards safety
c. Interpret safety manual directives
d. Comply with established company safety practices

2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when necessary
   e. Know the location(s) and type of fire extinguishers
   f. Review procedures for using emergency eye-wash station
3. Follow Safe Operating Procedures for Hand and Machine Tools
   a. Identify and understand safe machine operating procedures
   b. Demonstrate safe machine operation
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Clean machine/hand tools when work is completed
   c. Put tools away when work is finished
   d. Keep aisles clear of equipment and materials

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
2. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
3. Interconvert Metric/English Measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
4. Perform Basic Trigonometric Functions
   a. Solve for unknown angles
   b. Solve for unknown sides
5. Calculate Speeds and Feeds for Machining
   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut

C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes

D. RECOGNIZE DIFFERENT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
   a. Discuss classification system for metals
   b. Discuss general characteristics for carbon steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals
   c. List advantages for considering plastic as a viable materials choice
   d. List the advantages and disadvantages for each of the following plastic molding processes: blow, injection, vacuum, and extrusion
   e. Discuss the advantages for using composites in various manufacturing applications
2. Describe Heat Treating Processes
   a. Discuss the reasons for heat treating
   b. Discuss the time/temperature chart
   c. List the different quenching mediums
   d. Estimate metal temperature by color
   e. List reasons for stress relieving work piece
   f. Discuss surface hardening processes
3. Perform Heat Treating Operations
   a. Harden plain carbon steel work pieces
   b. Temper plain carbon steel work pieces
   c. Anneal plain carbon steel work pieces
   d. Case harden mild steel work pieces
4. Test Metal Samples for Hardness
   a. Perform spark test on carbon steels
   b. Perform Rockwell hardness tests
   c. Perform Brinell hardness tests

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. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
3. complete a stock request form for required material

4. provide a self-evaluation of performance based on the time and quality of work

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

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce machine parts to acceptable levels of quality as required
4. works well with all members of the class

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

1. read and interpret blueprints
2. organize and apply theories of machine tool operation
3. perform basic semi-precision and precision layout as necessary

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

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

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

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

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. studies student laboratory manual
   b. interprets blueprints and technical drawings
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. complete all written assignments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
   c. aligns machine and/or work holding device
   d. taps and threads
   e. keeps a running computation of individual grade
   f. interconverts fractions to decimal expressions
   g. use protractors to lay-out angle machining
   h. use trigonometry to solve angle and taper calculations
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions

d. assimilates process during instructor demonstrations

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
   c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters 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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools

d. accept the responsibility for self-management

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Technology of Machine Tools, 4th Ed., McGraw Hill Publishers

MET112
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*M*achine Tool *A*dvanced *S*kills
*T*echnology Program

MAST

COURSE SYLLABUS

CAD/CAM I

MAST PROGRAM
COURSE SYLLABUS
CAD/CAM I

Lecture hours/week: 3 **Lab hours/week: 3** **Credit hours: 4**

COURSE DESCRIPTION:

Student will introduced to "Process Modeling" utilizing a CNC graphics programming system called "SMARTCAM". Using engineering drawings, students will program various parts for both CNC mills and CNC lathes. Related topics include: job planning, tool selection, process model construction, tool path verification, machine simulation, quality control, CAD/CAM transfer and CNC code generation.

PREREQUISITES: NONE

REQUIRED COURSE MATERIALS:

Textbook: SMARTCAM-2D, Pelton, TSTC Pub., 2nd Ed.
Lab Manual: **NONE**

Materials and/or Supplies: 2 - double sided, high density 3 ½" floppy diskettes

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, overheads and SMARTCAM and related software demonstrations.

Laboratory: Laboratory will be a "hands-on" (computer based) process modeling using the SMARTCAM System.

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. demonstrate the ability to use DOS commands
2. create a basic procedure for machining a part on a machine center and a turning center, including: machine tool selection, tool selection and application, operational sequences, speeds, feeds and depth of cuts and tool length offsets
3. develop job plans using SMARTCAM
4. demonstrate the ability to develop a SHAPE file in the SMARTCAM graphics system
5. demonstrate the ability to manipulate files to successfully complete a graphics project within a CAM system
6. create part profiles and part geometry to produce accurately coded information for both CNC lathes and mills
7. utilize plotters and printers to produce accurate documents

8. perform and demonstrate the ability to transfer CAD files to CAM files and CAM files to CAD files
9. generate a tool path from CAD to CAM files
10. edit a tool path from a CAD file and proof the tool path from a CAD file.
11. satisfactorily perform on written, oral, and practical examinations
12. satisfactorily perform on outside assignments including writing assignments
13. contribute to class discussions
14. maintain attendance per current policy

LECTURE OUTLINE:

	Lecture Topic	Text Reference Page	Contact Hrs.
Unit 1	**CNC/CAD/CAM Overview**		
1.01	Description of CNC	handouts	
1.02	Computer Systems Review	and	
1.03	Job Opportunities in the CAM Field	overheads	
1.04	Employability Skills in CAM		
Unit 2	**The Structure of a CAM System**		
2.01	From Print to Part	5-6	
2.02	The Graphical User Interface	11-18	
2.03	Working with SMARTCAM's Display Areas	37-41	
Unit 3	**Process Planning (Mill)**		
3.01	Interpreting a Part Print	handouts	
3.02	Creating a Job Sheet from a Part Print	overheads	
3.03	Entering Tool Information into the Job Plan	28-29	
	Review for Quiz 1		
	Quiz 1		
	Return and Discuss Quiz 1		
Unit 4	**Working with a CNC Process Model (Mill)**		
4.01	Starting a CNC Process Model	19-24; 37-42	
4.02	Roughing and Finishing an Existing Process Model	and	
4.03	Modifying Existing Geometry	handouts	
4.04	Methods for Creating Geometry for the Process Model		
Unit 5	**Generating CNC Code with a CAM System**		
5.01	Basic NC Code Structure	overheads	
5.02	Locating the Data Source for Code Generation		
5.03	How a CAM System Generates CNC Code		
	Review for Quiz 2		

	QUIZ 2	
Unit 6	**Additional Modeling Practices**	
6.01	Pocketing and Facing with Islands/Notches, etc.	21-22
6.02	Re-sequencing Machining Operations	
6.03	Rotate, Move, Copy, Mirror and Scale Commands	overheads
Unit 7	**Process Planning (Lathe)**	
7.01	CNC Lathe Coordinate Systems	overheads
7.02	Carbide Tooling for CNC Lathes	overheads
7.03	Entering Tool Information into the Job Plan	overheads
Unit 8	**Working with a CNC Process Model (Lathe)**	
8.01	Turning, Facing, Boring and Drilling	overheads
	Review for Quiz 3	
	Quiz 3	
Unit 9	**Additional Modeling Practices**	
9.01	Threading Cycles and Grooving Cycle	overheads
9.02	Roughing for Turning and Facing Operations	
Unit 10	**Working with CAD Geometry**	
10.01	Conventions of CAD Geometry	overheads
10.02	Using a CAM System to Transfer CAD Geometry	
10.03	Working with CAD Geometry in a CAM System	
10.04	Transferring a CNC Process Model to a CAD System	
	Quiz 4 Review	
	Quiz 4	
	Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Job Plan	2
"Tryit" Exercises 1 thru 5	2
Simple Part Profile (Mill 1)	2
Simple Part Profile (Mill 2)	2
Profile with Roughing (Mill 3)	2
Using Multiple Tools (Mill 4)	2
Using Multiple Tools and Roughing (Mill 5)	2
Using Layers, Islands and Rough Facing (Mill 6)	3
Rough Processing (Mill 7)	2

Converting Geometry to Profiles, Using Copy (Mill 8)	2
Complex Part Geometry With Multiple Tools (Mill 9)	2
Using Rotate and Move Commands (Mill 10)	2
Roughing, Pocketing Drilling and Tapping (Mill 11)	2
Complex Modeling, Rotating, Moving Scaling (Mill 12)	3
Turning Lengths and Diameters (Lathe 1)	2
O.D. and I.D. Contour Turning (Lathe 2)	2
Multiple Tool with Roughing (Lathe 3)	2
Total Lab Hours	**36**

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
2. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
3. Interconvert Metric/English measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
4. Utilize Trigonometric Functions
   a. Solve for unknown angles
   b. Solve for unknown sides
5. Calculate Speeds and Feeds for Machining Using SMARTCAM's Job Plan Module
   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut
6. Locate Machining Points from a Datum Point
   a. Identify points using the Cartesian coordinate system
   b. Identify points using the absolute dimensioning system
   c. Identify points using the incremental dimensioning system

B. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Interpret basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes

2. Identify Basic Layout of Drawings
   a. Interpret the meaning of lines used within a drawing
   b. Identify item number symbols
   c. Identify general note symbols
   d. List the essential components found in the title block
   e. Locate bill of materials in a drawing
   f. Identify the components found in the revision block
3. Identify Basic Types of Drawings
   a. Interpret information found in orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)
   c. Visualize one or more views from a given view
   d. Identify isometric views
   e. Identify exploded isometric drawings
   f. Identify assembly drawings
4. Verify Drawing Elements
   a. Determine the scale of the view or section
   b. Check for revisions
   c. Recognize out-of-date blueprints
5. Practice Geometric Dimensioning and Tolerancing (GD&T) Methodology
   a. Identify the purpose of GD&T
   b. Identify symbols for controlling location (or true position) of part features
   c. Identify symbols for controlling form (or alignment) of part features
   d. Identify symbols for showing datums and basic dimensions on drawings
   e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)
6. Describe the Relationship of Engineering Drawings to Planning
   a. Discuss production schedule
   b. Discuss Material Resource Planning (MRP)
   c. Discuss inventory control records
7. Analyze Bill of Materials (BOM)
   a. Discuss components found on BOM
   b. Determine materials needed to produce the part
   c. Determine quantities necessary to produce the part
   d. Submit completed stock request form as required
   e. Submit completed tool request form as needed

C. RECOGNIZE DIFFERENT MANUFACTURING MATERIALS & PROCESSES

1. Identify Materials With Desired Properties
   a. Discuss classification system for metals

D. PERFORM ADVANCED MACHINING PROCESSES

1. Prepare and Plan For CNC Machining Operations
   a. Read and interpret blueprints
   b. Plan CNC machining operations
   c. Calculate speeds, feeds, and depth of cut for various CNC machine applications
   d. Determine proper cutting fluids/coolants for CNC machining
   e. Use the Machinery's Handbook as a reference for CNC machine applications
2. Select and Use CNC Tooling Systems

a. Understand machinability and chip formation
b. Select proper insert materials and geometry
c. Assemble tooling components
d. Select correct tooling systems
e. Identify tooling cost factors

3. Program CNC Machines
   a. Identify CNC applications
   b. List various types of CNC machines
   c. Discuss CNC machine control systems
   d. Describe absolute and incremental coordinate systems
   e. Plan and write programs for CNC lathes
   f. Plan and write programs for CNC mills
4. Operate CNC Machining Centers (Mills)
   a. Install and align work holding devices
   b. Load/align materials into the machine
   c. Load tools into machine
   d. Establish tool length offset for each tool
   e. Establish/set machine reference
   f. Load programs into CNC mill
   g. Demonstrate working knowledge of all controls on the MCU
   h. Demonstrate proper operation of CNC machining center to include "dry run" and final production
   i. Edit CNC programs for optimum part production
   j. Operate machine in DNC mode if that capability exists
5. Download Programs Via Network
   a. Download programs from the network
   b. Upload programs to the network
   c. Perform edit and print functions via network
6. Program CNC Machines using a CAM system
   a. Create Job Plan for machining operations
   b. Construct part geometry
   c. Program tool path for roughing and finishing operations
   d. Verify tool path
   e. Generate CNC code

E. USE COMPUTERS

1. Use Computer Operating Systems
   a. Use basic computer terminology appropriately and accurately
   b. Boot the computer and recognize the basic components of DOS
   c. Use DOS to perform file management
   d. Use DOS to perform directory management

COURSE OBJECTIVES: SCANS COMPETENCIES

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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. follows a schedule to complete assigned tasks on time
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  1. complete assigned responsibilities within the shop floor serving as a member of the team
  2. provide individual assistance/direction to peers as requested
  3. produce machine parts to acceptable levels of quality as required
  4. works well with all members of the class
- *C. Information: Acquires and uses information*
  1. read and interpret blueprints
  2. organize and apply theories of machine tool operation
- *D. Systems: Understands complex inter-relationships*
  1. demonstrate knowledge of the following systems:
     a. laboratory organization structure: physical and social
     b. organization of personnel and facilities on the shop floor
     c. systematic approach to the metal removal process
     d. dimensioning and measurement systems
     e. systematic organization of training materials
  2. monitors and corrects performance during
     a. the machining process
     b. adjustments of individual laboratory work schedule
     c. constantly evaluating the quality of work to achieve acceptable standards
     d. maintains record of evaluations and sets individual goals
- *E. Technology: Works with a variety of technologies*
  1. chooses procedure, tools and equipment required to produce a part
  2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards
  3. maintains and troubleshoots equipment
     a. applies appropriate preventative maintenance
     b. when operating machines

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. studies student laboratory manual
   b. interprets blueprints and technical drawings
   c. read/studies textbook
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2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
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   c. submit written responses to chapter question assignments
   d. complete all written assignments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
   c. taps and threads
   d. keeps a running computation of individual grade
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1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
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2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility

3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
   c. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters 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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. *Self-Esteem: Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual gradebook)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. SMARTCAM Advanced 3-D Machining Reference Manual
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers
3. Machine Tool Catalogs

MET302
01/072396

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

MAST

COURSE SYLLABUS

MOLD MAKING I

MAST PROGRAM
COURSE SYLLABUS
MOLD MAKING I

Lecture hours/week: 3 **Lab hours/week: 9** **Credit hours: 6**

COURSE DESCRIPTION:

This course is designed to introduce students to the field of mold making for the plastic industry. Focus is placed on the theory of mold operation and function, mold identification, basic mold design factors, and basic machine tool operations performed by the mold maker.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Injection Molds and Molding, by Joseph B. Dym
Introduction to Mold Making, by The Southwestern Michigan Chapter of the AMERICAN MOLD BUILDERS ASSOCIATION

Lab Manual: **NONE**

Hand Tools/Quantity Required: Basic Tool List (See Machine Tool Practices I)

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures, discussions, visual aids, and demonstrations.

Laboratory: Laboratory will consist of "hands on" activities which will enable the student to learn the skills necessary to repair and make thermal plastic injection molds for the plastics industry.

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.
A Comparison of Common Molding Processes		3
Blow Molding		2
Rubber Molding		2
Compression Molding of Thermoset Plastics		2
Transfer Molding of Thermoset Plastics		2
Injection Molding and Injection Molds		6
Molds for Die Casting		3
Standard Mold Components		2
Producing Cavities		3
Mold Actions		2
Runners, Gates and Vents		2
Cooling and Heating Molds		2
Surface Finishes for Molds		2
Fabrication Materials for Molds		3
	Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Preparation of mold bases	16
Manufacture of Simulated Core and Cavity Plates	60
Cutting, milling and grinding	
Squaring pockets, locks, vents, leader pins, runners	
counterboring, clearance and fit	
Assembly/disassembly of injection mold	16
Mold polishing basics	16
Total Lab Hours	**108**

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. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Interpret safety manual directives
   d. Comply with established company safety practices

2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when handling molds or other heavy materials (e.g., eye bolts, slings, cables)
3. Debur Mold Bases to Help Avoid Cuts
   a. Chamfer outside edges of mold bases
   b. Do not debur parting edges of mold cavities, runners, gates, etc.
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Keep machine and hand tools clean at all times
   c. Put tools away when not in use
   d. Keep aisles clear of equipment and materials

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
2. Locate Machining Points from a Datum Point
   a. Identify points using the Cartesian coordinate system
   b. Identify points using the polar coordinate system
   c. Identify points using the absolute dimensioning system
   d. Identify points using the incremental dimensioning system
   e. Identify reasons for establishing datum point in the center of the mold base
3. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
4. Interconvert Metric/English measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
5. Perform Basic Trigonometric Functions
   a. Solve for unknown angles
   b. Solve for unknown sides
   c. Calculate for bolt circles
6. Use Sine Bar or Sine Plate for Machine Operations
   a. Use trigonometric tables for solutions
   b. Use calculator for solutions
   c. Calculate gage block build up
7. Calculate Draft Angles
   a. Discuss reason for draft in the mold
   b. Discuss recommended draft angles for various molding processes
   c. Use D-M-E table to determine draft angles for parts of different thickness

8. Calculate Runner Size for Molding
   a. Calculate optimum runner diameter
   b. Calculate optimum runner length
9. Apply "Shrink Rate" Formulas
   a. Discuss shrink figures for various thermoplastic materials
   b. Discuss causes for shrink rate variations
   c. Apply shrink rate formulas to mold design
10. Calculate Speeds and Feeds for Machining
   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut

C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify item number symbols
   c. Identify general note symbols
   d. List the essential components found in the title block
   e. Locate bill of materials in a drawing
   f. List the components found in the revision block
3. Identify Basic Types of Drawings
   a. Identify orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)
   c. Visualize one or more views from a given view
   d. Identify isometric views
   e. Identify exploded isometric drawings
   f. Identify assembly drawings
4. List the Purpose of Each Type of Drawing
   a. Discuss purpose of orthographic (3 views) drawings
   b. Discuss purpose of isometric drawing
   c. Discuss purpose of exploded isometric drawing
   d. Discuss purpose of assembly drawings
5. Verify Drawing Elements
   a. Determine the scale of the view or section
   b. Check for revisions
   c. Recognize out-of-date blueprints
6. Identify Lines and Symbols (GD&T)

a. Discuss the reason for GD&T
b. Identify symbols for controlling location (or true position) of part features
c. Identify symbols for controlling form (or alignment) of part features
d. Identify symbols for showing datums and basic dimensions on drawings
e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)

7. Describe the Relationship of Engineering Drawings to Planning
   a. Discuss production schedule
   b. Discuss Material Resource Planning (MRP)
   c. Discuss inventory control records
   d. Discuss shop floor routing documents
8. Use Standards to Verify Requirements
   a. Discuss the purpose of standards
   b. Discuss source locations for standards
9. Analyze Bill of Materials (BOM)
   a. Discuss components found on BOM
   b. Discuss components found in parts lists
10. Create Technical Sketches
   a. Discuss the value of sketching as a communication tool
   b. Describe basic orthographic sketching techniques
   c. Describe basic isometric sketching techniques
   d. Draw a sketch of a machine part

D. SELECT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
   a. Discuss classification system for metals
   b. Discuss general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals
2. Identify Heat Treating Processes
   a. Discuss the reasons for heat treating
   b. Discuss the time/temperature chart
   c. List the different quenching mediums
   d. Estimate metal heat temperature by color
   e. Discuss purpose of normalizing
   f. Discuss purpose of annealing
   g. Discuss purpose of stress relieving
   h. Discuss purpose of hardening
   i. Discuss purpose of tempering
   j. Discuss purpose of nitriding
3. Identify Plastic Molding Processes
   a. Describe the blow molding process
   b. Describe the vacuum forming process
   c. Describe the injection molding process
   d. Describe the reaction injection molding process
   e. Describe the extrusion molding process
   f. Describe the compression molding process

g. Describe the transfer molding process
h. Describe the rotational molding process
i. Discuss the advantages of using composites
j. Describe the composite molding methods

4. Identify Types of Mold Steels
   a. Discuss mold service requirements
   b. Discuss mold hardness requirements
   c. Discuss machinability of mold steel
   d. Describe P-20, Plastic Mold Steel
   e. Describe A-2, Cold Work Tool Steel
   f. Describe S-1, Shock Resisting Tool Steel
   g. Describe H-13, Chromium type Hot Work Tool Steel
   h. Describe S-7, Shock Resisting Tool Steel
   i. Describe Type 414, Stainless Plastic Mold Steel
   j. Describe Type 420, Stainless Plastic Mold Steel

E. PERFORM MEASUREMENT/INSPECTION

1. Identify Types of Measurement
   a. Distinguish between direct and calculated measurements
   b. Compute calculated measurements
   c. Justify the use of precision measurements in manufacturing
   d. Discuss the following: precision, reliability and accuracy
   e. Demonstrate general measurement techniques
   f. Demonstrate semi-precision measurement techniques
   g. Demonstrate precision measurement techniques
   h. Document results of measurement activities and calculations
2. Select Proper Measurement Tools
   a. Match appropriate measurement tools with various types of measurement requirements
   b. Demonstrate proper measurement tool usage
   c. List steps of proper measurement
   d. Explain rationale for each step
   e. Identify error possibilities in measurement tool selection
   f. Identify error possibilities within measurement procedures
   g. Identify common conversion error possibilities
   h. Discriminate between accepted measurement procedures and improper measurement procedures
3. Apply Proper Measuring Techniques
   a. Explain calibration requirements of various precision instruments
   b. Illustrate measurement differences when taken with calibrated and non-calibrated instruments
   c. Justify use of particular measurement tools based on tool characteristics
   d. Discuss factors affecting accurate measurement (dirt, temperature, etc.)
4. Measure With Hand Held Instruments
   a. Measure with steel rules (metric and inch)
   b. Measure with micrometers

c. Measure with comparison measuring instruments (e.g., calipers, telescope gages, etc.)
d. Measure with direct measuring instruments (e.g., vernier, dial, and digital instruments)
e. Measure with fixed gages (go and not go gages)

5. Measure/Layout/Inspect Using Surface Plate
   a. Describe and properly use surface plate
   b. Use surface plate accessories correctly (sine bar, gage blocks, etc.)
   c. Check for part squareness
   d. Check part dimensions for accuracy
   e. Align workpieces using height gage and dial indicators

F. PERFORM CONVENTIONAL MACHINING OPERATIONS

1. Prepare and Plan For Machining Operations
   a. Read and interpret blueprints
   b. Perform basic semi-precision and precision layout as necessary
   c. Plan machining operations
   d. Understand machinability and chip formation
   e. Calculate speeds, feeds, and depth of cut for various machine applications
   f. Use carbides and other tool materials to increase productivity
   g. Use the Machinery's Handbook as a reference for machine applications
2. Use Proper Hand Tools
   a. Use arbor and shop presses
   b. Select necessary work-holding devices and hand tools as needed
   c. Select and use hand files
   d. Identify and use hand reamers
   e. Correctly identify and use hand taps as required
   f. Follow tapping procedures to produce internal threads
   g. Use thread-cutting dies to produce external threads
   h. Operate bench and pedestal grinders safely
3. Operate Power Saws
   a. Use reciprocating and horizontal band cutoff machines
   b. Operate abrasive and cold saws
   c. Prepare and use the vertical band saw
   d. Weld a bandsaw blade
4. Operate Drill Presses
   a. Describe the different types of drill presses found in the machine shop
   b. Describe and use standard drilling tools
   c. Sharpen a drill bit using a bench or pedestal grinder
   d. Setup the drill presses for drilling, countersinking, counterboring, reaming, and tapping operations
   e. Drill holes using drill jigs
5. Operate Vertical Milling Machines
   a. Demonstrate the use of all controls on the vertical milling machine
   b. Align the vertical milling machine head
   c. Select, align and use workholding devices

d. Select milling tool holders
e. Select milling cutters
f. Perform all standard vertical milling operations
g. Bore a hole using the offset boring head
h. Machine angles using sine bar and gage blocks
i. Setup and use special vertical mill fixtures
j. Setup and machine dovetails
k. Machine keyways

6. Operate Horizontal Milling Machines
   a. Discuss the difference in plain and universal horizontal milling machines
   b. Discuss the types of spindles, arbors and adaptors used on the horizontal milling machine
   c. List several common work holding methods
   d. Use plain milling cutters
   e. Use side milling cutters
   f. Use face milling cutters
   g. Setup and use special horizontal mill fixtures
7. Operate Metal Cutting Lathes
   a. Demonstrate the use of all controls on the engine lathe
   b. Discuss standard tools and toolholders for the lathe
   c. Face and center drill parts correctly
   d. Drill, ream and bore on the lathe
   e. Turn between centers
   f. Discuss alignment of lathe centers
   g. Make all calculations, lathe adjustments and settings to machine sixty-degree internal and external threads
   h. Discuss thread fit classifications
   i. Make all calculations, lathe adjustments and settings to machine Acme threads
   j. Describe the common tapers used in the machine shop
   k. Discuss taper cutting and calculations for the lathe
   l. Setup and use the taper attachment found on most lathes
   m. Use follower rests and steady rests
   n. Use HSS cutting tools
   o. Use carbide cutting tools
   p. Setup and operate tracer lathes
   q. Setup and operate turret lathes
8. Operate Grinding/Abrasive Machines
   a. Discuss the selection and identification of grinding wheels
   b. Inspect, mount, true, dress, and balance grinding wheels
   c. True table by indicator
   d. True back rail by indicator
   e. Make the form in the wheel
   f. Check the form in the wheel
   g. Discuss the selection of grinding fluids

h. Operate horizontal spindle reciprocating table surface grinders
i. Operate cylindrical grinders
j. Operate ID and OD grinders
k. Setup and operate tool and cutter grinders
l. Discuss common problems and solutions in surface grinding
m. Operate honing machine
n. Operate lapping machines

9. Operate Deburring Equipment
   a. Debur parts using pneumatic Deburring tools
   b. Debur parts using electric deburring tools
10. Polish Mold Cavities
   a. Discuss finish requirements of molds
   b. Discuss surface finish symbols
   c. Select abrasive for mold finishing
   d. Describe steps for achieving "mirror" finish
   e. Describe molding problems related to poor surface conditions

G. BUILD/REPAIR/MODIFY MOLDS

1. Identify Types of Molds (e.g., three plate, multi-cavity, cam action, hot runner)
   a. Identify/describe three plate mold
   b. Identify/describe multi-cavity molds
   c. Identify/describe runnerless molds
   d. Identify/describe cam action molds
2. Identify Typical Mold Components (e.g., cavity and core insert, ejector mechanisms, etc.)
   a. Identify/describe cavity inserts
   b. Identify/describe core inserts
   c. Describe engraving inserts
   d. Identify/describe ejector pins, blades and ejector plates
   e. Identify/describe stripper plates and rings
   f. Discuss and/or install compressed air ejector systems
3. Estimate Basic Mold Cost Considerations (e.g., engineering, material, labor)
   a. Discuss factors relating to molding process (high vs. low pressure)
   b. Discuss factors relating to molding material (hard vs. easy flow)
   c. Discuss factors relating to volume
   d. Discuss factors relating to part size
   e. Discuss factors relating to part complexity
   f. Discuss factors relating to part tolerances
4. Apply Basic Mold Design: Principles (nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs)
   a. Describe types of runner systems (e.g., full, half, quarter, trapezoidal, and modified trapezoidal)
   b. Describe laminar and turbulent flow
   c. Discuss the purpose of cold slug extensions
   d. Discuss recommended runner size for various materials

e. Discuss common gate types (e.g., jump, tunnel, tab, ring, sprue, center, fan)
f. Discuss mold venting (e.g., location, size, solutions)
g. Discuss wall thickness
h. Discuss part radius considerations
i. Discuss rib design and placement
j. Discuss draft angles

5. Install Mold Temperature Control Devices
   a. Describe mold baffles
   b. Describe mold bubblers
   c. Describe design of water line placements
   d. Discuss mold cooling problems
6. Disassemble/Assemble Molds
   a. Completely disassemble a mold base
   b. Identify all components
   c. Assemble mold base to working condition
7. Identify "Off the Shelf" Mold Components
   a. Identify sources of molding components
   b. Use catalogues to order components for mold construction
8. Construct a Cavity and Core for an Injection Mold
   a. Machine a cavity for a mold
   b. Machine a core for a mold
   c. Install the components into the mold
   d. Check for proper mold operation
9. Build/Assemble/Adjust Ejector Plates and Pins
   a. Select proper type of ejector mechanism
   b. Determine size and placement of ejectors
   c. Locate, drill and assemble ejector plate w/ejector pins
   d. Assemble, measure, and final grind ejector lengths for proper clearance
   e. Check final operation of ejector mechanism
10. Vent Molds
   a. Determine mold vent requirements
   b. Determine mold size requirements
   c. Determine optimum mold locations
   d. Machine vent openings
   e. Hand finish vent to cavity openings
   f. Check final operation for "flash" and proper mold filling
11. Perform Preventative Maintenance (e.g., mold cleaners, mold releases, rust preventatives)
   a. Select/use mold cleaners
   b. Select/use mold releases
   c. Select/use rust preventatives
   d. Use "soft tools" around mold cavities

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. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
3. provide a self-evaluation of performance based on the time and quality of work

B. Interpersonal: Works with others

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. machine mold components to acceptable levels of quality as required
4. works well with all members of the class

C. Information: Acquires and uses information

1. read and interpret blueprints
2. organize and apply theories of mold design and construction

D. Systems: Understands complex inter-relationships

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the mold design and construction
   d. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

E. Technology: Works with a variety of technologies

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a molded part to acceptable standards

3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

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. studies student laboratory manual
   b. interprets molding machine manuals
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. maintain a lecture notebook
   b. submit written responses to chapter question assignments
   c. complete all written assignments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum mold design parameters for various plastic polymers
   b. calculates "value added to the part"
   c. adjusts machine parameters to achieve a quality part

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the technician
   c. understands the relationship between different plastic materials and mold design variables and makes adjustments as necessary

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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement

b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Moldmaking and Die Cast Dies for Metalworking Trainees, by John Kluz. National Tooling and Machining Association.

MET211
01/072496

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

MAST

COURSE SYLLABUS

STATICS

MAST PROGRAM
COURSE SYLLABUS
STATICS

Lecture hours/week: 3 **Lab hours/week: 3** **Credit hours: 4**

COURSE DESCRIPTION:

This is a basic course in applied Statics and Mechanics and will prepare the student for courses in Strength of Materials and Machine Design. The student will acquire a fundamental understanding of concepts and principles which apply in the calculations of such things as: levers, structural members, inclined planes, sheaves, machined parts and structural joints. Other topics will include: coplanar forces, equilibrium of forces, structural analysis, free-body diagrams, laws of friction and the calculation of centroids and centers of gravity.

PREREQUISITES: Plane Trigonometry

REQUIRED COURSE MATERIALS:

Textbook: Applied Statics and Strength of Materials, Spiegel and Limbunner, Merrill Publishers

Lab Manual: **NONE**

Required Materials:

Engineering paper, green
Scientific Calculator

METHODS OF INSTRUCTION:

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

Laboratory: Laboratory assignments will require student to solve appropriate static problems.

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

LECTURE OUTLINE:

	Lecture Topics	Text Reference Page	Contact Hrs.
Unit 1	**Introduction to Mechanics**	**1-16**	
1.01	Definition of Mechanics	1	
1.02	Problem in Applied Mechanics	1-2	
1.03	Procedures in the Solution on Mechanics Problems	3-5	
1.04	Standards of Workmanship in Problem Solutions	9-12	
Unit 2	**Basic Principles of Statics**	**17-71**	
2.01	Force	17	
2.02	Types of Force	17	
2.03	Characteristics and Units of a Force	17	
2.04	Vector and Scalar Quantities	19	
2.05	Transmissibility of Force	18	
2.06	Types of Force Systems	21	
2.07	Components of a Force	22	
2.08	Resultant of Two Concurrent Forces	36	
2.09	Moments of a Force	47	
2.10	The Principles of Moments Viraginous Theorem	51	
2.11	Couples	59	
2.12	Resultant of Parallel Forces	53	
2.13	Resolution of a Force into Parallel	53	
2.14	Equilibrium of Force Systems Components	75	
2.15	Principles of Force Equilibrium	75	
2.16	Supports and Support Reactions		
2.17	Free-body Diagrams	76	
2.18	Problems in Equilibrium of Coplanar Force Systems		
Unit 3	**Coplanar, Parallel Force Systems**	**36-91**	
3.01	Resultant of Coplanar, Parallel Forces	36-71	
3.02	Resultants of Distributed Loads	36-71	
3.03	Equilibrium of Coplanar, Parallel Force Systems	75-91	
Unit 4	**Coplanar, Concurrent Force Systems**	**53-112**	
4.01	Resultants of Coplanar, Concurrent Force Systems	36-71	
4.02	Equilibrium of Coplanar, Concurrent Force Systems	5-91	
4.03	Trusses	109	
4.04	Stresses in Members of Trusses	111	
4.05	Ropes over Sheaves and Pulleys		
4.06	Stresses in Trusses; Analytical		

	Method of Joints	112-118
4.07	Stresses in Trusses; the Graphical Method of Joints	112-118
4.08	Stresses in Trusses; the Graphical Method of Combined Diagrams	112-118
4.09	Three-force Members	
4.10	Graphical Determination of Reactions Using Three-force Principle	
Unit 5	**Coplanar, Nonconcurrent Force Systems**	**62-119**
5.01	Resultant of Coplanar, Nonconcurrent Force Systems	62
5.02	Equilibrium of Coplanar, Nonconcurrent force Systems	93
5.03	Determination of Reactions; Graphical String-polygon Method	
5.04	Determination of Reactions; Analytical Method	112-118
5.05	Pin Reactions; the Method of Members	
5.06	Stresses in Trusses; the Method of Sections	119
5.07	Counter Diagonals in Trusses	
Unit 6	**Noncoplanar, Parallel Force Systems**	**75-105**
6.01	Resultant of a Noncoplanar, Parallel Force Systems	
6.02	Equilibrium of Noncoplanar, Parallel Force System	
Unit 7	**Noncoplanar, Concurrent Force Systems**	**75-105**
7.01	Components of a Force in Space	
7.02	Equilibrium of Noncoplanar, Concurrent Force Systems	
Unit 8	**Noncoplanar, Nonconcurrent Force Systems**	**75-105**
8.01	Equilibrium of Noncoplanar, Nonconcurrent Force Systems	93
Unit 9	**Friction**	**143-165**
9.01	Coefficient of Friction, Angle of Friction, and Angle of Repose	143-146
9.02	Laws of Friction	144
9.03	Friction Problems	147.
9.04	Belt Friction	165
9.05	Rolling Resistance	
	Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Introduction to Mechanics	2
Basic Principles of Statics	6
Coplanar, Parallel Force Systems	3
Coplanar, Concurrent Force Systems	6
Coplanar, Nonconcurrent Force Systems	4
Noncoplanar, Parallel Force Systems	3
Noncoplanar, Concurrent Force Systems	3
Noncoplanar, Nonconcurrent Force Systems	3
Friction	6
Total Lab Hours	**36**

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
2. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
3. Interconvert Metric/English measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
4. Perform Basic Trigonometric Functions
   a. Solve for unknown angles
   b. Solve for unknown sides
5. Solve Static Systems for Resultant Forces
   a. Solve for the following coplanar force systems: parallel, concurrent and nonconcurrent
   b. Solve for the following Noncoplanar force systems: parallel, concurrent and nonconcurrent
6. Solve Engineering Equations
   a. Solve linear algebraic equations for an unknown
   b. Solve a system of linear equations with 2 unknowns
   c. Solve right triangles for unknown sides or angles
   d. Use the law of sines and cosines to solve obtuse triangles with unknown sides and angles
   e. Calculate factors of Friction
7. Use all Functions of a Scientific Calculator
   a. Apply all trigonometric functions
   b. Apply all algebraic functions

c. Apply all statistical functions

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. follows a schedule to complete assigned tasks on time
2. provide a self-evaluation of performance based on the time and quality of work

B. Interpersonal: Works with others

1. complete assigned responsibilities within the class serving as a member of the team
2. provide individual assistance/direction to peers as requested

C. Information: Acquires and uses information

1. read and interpret blueprints
2. organize and apply theories of mechanics, forces and friction

D. Systems: Understands complex inter-relationships

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. systematic organization of training materials
2. monitors and corrects performance during
   a. adjustments of individual laboratory work schedule
   b. constantly evaluating the quality of work to achieve acceptable standards
   c. maintains record of evaluations and sets individual goals

E. Technology: Works with a variety of technologies

1. chooses procedure and formulas necessary for problem solving.

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. studies student laboratory manual
b. interprets diagrams and technical drawings
c. read/studies textbook

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary for problem solving
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. complete all written assignments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. add, subtract, multiply and divide whole numbers
   b. add, subtract, multiply, and divide fractions
   c. add, subtract, multiply, and divide decimals
   d. convert fractions to decimal equivalents
   e. convert decimal values to nearest fractional equivalent
   f. use Decimal Equivalent Chart for conversions
   g. convert English dimensions to Metric
   h. convert Metric dimensions to English
   i. use Metric/English conversion chart
   j. solve for unknown angles
   k. solve for unknown sides
   l. solve for the following coplanar force systems: parallel, concurrent and nonconcurrent
   m. solve for the following noncoplanar force systems: parallel, concurrent and nonconcurrent
   n. solve linear algebraic equations for an unknown
   o. solve a system of linear equations with 2 unknowns
   p. solve right triangles for unknown sides or angles
   q. use the law of sines and cosines to solve obtuse triangles with unknown sides and angles
   r. calculate factors of friction
   s. apply all trigonometric calculator functions
   t. apply all algebraic calculator functions
   u. apply all statistical calculator functions
   v. calculates coplanar, parallel force systems
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. observe laboratory demonstrations
   c. seek and receive individualized instruction in the laboratory
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill

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. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the technician

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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. assist classmates in improving technical skills
b. assist students with special needs as a peer mentor

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process checks on calculations
   b. maintain a record of academic achievement (individual gradebook)
   c. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Applied Statics and Strength of Material, Spiegel and Limbunner

MET206
01/072396

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

MAST

COURSE SYLLABUS

COMPOSITES

MAST PROGRAM
COURSE SYLLABUS
COMPOSITES

Lecture hours/week: 1 **Lab hours/week: 3** **Credit hours: 2**

COURSE DESCRIPTION:

Introductory course showing the benefits of combining various types of reinforcing elements (fibers) with a polymer resin (matrix) to yield specific characteristics and properties not attainable by either constituent acting alone.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Introduction to Composites, Published by SPI. Latest edition.
Lab Manual: **NONE**

Hand Tools/Quantity Required: Safety Glasses
Brown Jersey Gloves

METHODS OF INSTRUCTION:

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

Laboratory: Laboratory will consist of "hands on" activities which will enable the student to learn the selection and preparation of raw materials, machining functions, mold set up, and the use of auxiliary equipment associated with injection molding.

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. describe the basic components of a polymer composite
4. list the major marketplace applications of polymer composites
5. describe the various advantages of using polymer composites
6. design and fabricate a small bench top polymer composite structure
7. satisfactorily perform on written, oral, and practical examinations
8. satisfactorily perform on outside assignments including writing assignments
9. contribute to class discussions

10. maintain attendance per current policy
11. follow all shop rules and safety regulations as stated in the laboratory manual

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Composite Materials		4
a. Resins		
b. Reinforcements		
c. Fillers/Additives		
Introduction to Composite Processes		6
a. Open/Contact molding		
b. Compression molding		
c. Filament winding		
d. Injection molding		
Designing with Composites		2
a. Economics of composites		
b. The future of composites		
	Total Lecture Hours	**12**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Reinforced reaction injection molding (RRIM)	8
Resin Transfer Molding (RTM)	8
Pultrusion	8
Other composite molding processes	12
Total Lab Hours	**36**

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. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Interpret safety manual directives
   d. Comply with established company safety practices
2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when handling molds or other heavy materials (e.g., eye bolts, slings, cables)
3. Debur Mold Bases to Help Avoid Cuts
   a. Chamfer outside edges of mold bases

4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Keep machine and hand tools clean at all times
   c. Put tools away when not in use
   d. Keep aisles clear of equipment and materials

B. SELECT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
   a. Discuss classification system for plastics
   b. Discuss general characteristics for various plastic materials
2. Identify Types of Plastic Materials
   a. Discuss advantages of using plastics
   b. Discuss classifications of plastics
   c. Discuss forms available forms (e.g., resins, coatings, adhesives, laminates, compounds)
   d. Discuss properties
3. Identify Plastic Molding Processes
   a. Discuss the advantages of using composites
   b. Describe the composite molding methods
4. Perform Preventative Maintenance (e.g., mold cleaners, mold releases, rust preventatives)
   a. Select/use mold cleaners
   b. Select/use mold releases
   c. Select/use rust preventatives
   d. Use "soft tools" around mold cavities

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. follows a schedule to complete assigned tasks on time
   2. determine the initial cost of materials and "value added" as result of processing
   3. provide a self-evaluation of performance based on the time and quality of work

B. Interpersonal: Works with others

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce molded parts to acceptable levels of quality as required
4. works well with all members of the class

C. *Information: Acquires and uses information*
1. read and interpret blueprints
2. organize and apply theories of plastic molding equipment operation

D. *Systems: Understands complex inter-relationships*
1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the plastic molding process
   d. systematic organization of training materials
2. monitors and corrects performance during
   a. the molding process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

E. *Technology: Works with a variety of technologies*
1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a molded part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

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. studies student laboratory manual
   b. interprets molding machine manuals
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts
   a. outline the steps necessary to produce a molded plastic part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments

d. complete all written assignments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum time and temperature settings for various plastic polymers
   b. calculates "value added to the part"
   c. adjusts timers and heaters to maintain a quality part
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*

a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the technician
c. understands the relationship between different plastic materials and the processing variables and adjusts molding parameters 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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on molded parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

MET345
01/072496

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

MAST

COURSE SYLLABUS

INTRODUCTION TO COMPUTER DRAFTING

MAST PROGRAM
COURSE SYLLABUS
INTRODUCTION TO COMPUTER DRAFTING

Lecture hours/week: 1 **Lab hours/week: 4** **Credit hours: 2**

COURSE DESCRIPTION:

This course introduces the student to computer-aided drafting (CAD). This introduction involves equipment, software, and basic command logic. Graphic images are created using introductory level commands.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: AutoCAD and Its Applications. Terence Shumaker/David A. Madsen

Materials:
2 - HHDS 3 ½" diskettes
1 Ream of plain bond paper (20lb)
Notebook Paper
Felt tip pen
1 Pkg Calcomp Plotter Pens - Assorted Colors

METHODS OF INSTRUCTION:

Lecture: Classroom presentations will include lecture, video and demonstrations. Computer assisted instruction will be used.

Laboratory: Laboratory will be a "hands-on" drawing process using computer hardware, software, plotters and printers.

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 safety regulations as stated in the class policies

LECTURE OUTLINE:

Lecture Topics	Text Reference Page	Contact Hrs.
Introduction to Course	----	
Required Materials and Tests	Handout	
Class Policies and Safety Concerns	Handout	
System Orientation	Appendix B, 1	
Operating Parameters and Drawing Aids	Chapters 2, 3, 4, 5	
Cartesian Coordinates	Chapter 6	
Display Commands	Chapter 9	
Draw Commands	Chapters 6, 7, 8, 13	
Edit Commands	Chapters 11, 12	
Text Commands	Chapter 10	
Inquiry Commands	Chapter 14	
DOS/Utility Commands	Chapters 15, 35	
Plot Specifications	Chapter 27	
Layer Command	Chapter 17	
Blocks	Chapter 21	
Dimensioning	Chapter 18	
Manufacturing/CAD Project		
	Total Lecture Hours	**12**

LAB OUTLINE:

Lab Topics	Contact Hrs.
System Orientation	2
Operating Parameters	2
Cartesian Coordinates	4
Displaying Different Views	1
Drawing Entities	4
Editing Existing Entities	2
Text on the Drawings	2
Inquiry - Obtaining Database Information	1
DOS/Utility Commands	1
Plotting	1
Using Layers	2
Creating Blocks	4
Dimensioning Drawings	4
Project	18
Total Lab Hours	**48**

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

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

A. PRACTICE SAFETY

1. Follow Safety Requirements
   a. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Comply with established safety practices
   d. Use special caution with magnetic media
2. Maintain a Clean and Safe Work Environment
   a. Observe computer lab hygiene
   b. Put equipment and supplies away when work is finished

B. APPLY MATHEMATICAL CONCEPTS

1. Use Inquiry Commands to Perform Basic Addition and Subtraction
2. Use Inquiry Commands to Find Area, Length and Distance
3. Apply Basic Concepts of Geometry Using CAD Software
4. Convert English Dimensions to Metric

C. APPLY DRAFTING CONCEPTS TO COMPUTER AIDED DRAFTING

1. Identify the Equipment Used in Computer Aided Drafting
2. Describe the Methods and Procedures Used to Produce Cad Drawings

D. ESTABLISH AND USE OPERATING PARAMETERS

1. Use Dos Commands to Manage Drawing Files
2. Describe and Use Menus and Screen Prompts
3. Set UNITS
4. Set LIMITS
5. Set GRID
6. Set SNAP
7. Establish a Prototype Drawing
8. Open, Close and Save Files
9. Use ORTHO to Create Lines at Right Angles

E. USE CARTESIAN COORDINATE POINT ENTRY SYSTEMS

1. Create Drawings Using Absolute Coordinates
2. Create Drawings Using Relative Coordinates
3. Create Drawings Using Polar Coordinates
4. Determine Which System Is Most Efficient for Each Application

F. USE DISPLAY COMMANDS TO VIEW DRAWINGS

1. Enlarge or Reduce the Amount of Drawing Displayed on the Monitor Using Zoom Options
2. Redraw the Screen to Clean up Clutter
3. Specify and Save Certain Views on a Drawing
4. Manipulate Your View of the Drawing Without Changing the Magnification

G. USE CAD COMMANDS TO CREATE DRAWINGS

1. Determine Most Efficient Sequence of Commands to Produce Required Object
2. Use Standard Line Types to Indicate Drawing Features
3. Use POLYLINES to Show Width And/or Taper

4. Draw Circles Using the CIRCLE Command Options
5. Draw Arcs Using the ARC Command Options
6. Use Ellipses, Polygons and Doughnuts to Represent Drawing Features
7. Use OSNAPS to Create Accurate Geometry
8. Use ARRAY to Create Rectangular and Circular Repetitions

H. USE CAD COMMANDS TO EDIT DRAWINGS

1. Create Angled Corners Using the CHAMFER Command
2. Create Rounded Corners Using the FILLET Command
3. Remove Portions of Entities Using the BREAK Command
4. Change the Location of an Entity
5. Use TRIM and EXTEND to Shorten or Lengthen an Object
6. Use COPY to Create Duplicates of Existing Objects
7. Change Angular Position of Objects
8. Use the STRETCH and SCALE Commands to Change to Size Length and Height of an Object

I. PLACE TEXT ON A DRAWING

1. Use the Text Command to Add Notes and Callouts to a Drawing
2. Set Text Style
3. Draw Special Symbols Using Control Characters
4. Underscore and Overscore Text
5. Edit Existing Text

J. OBTAIN INFORMATION ABOUT A DRAWING

1. Determine the Area of an Object by Adding and Subtracting Entities
2. List Database Information Related to Entities and Drawings
3. Track Time Spent in a Drawing Session

K. USE DOS/UTILITY COMMANDS TO MANAGE FILES

1. Explain the Meaning and Use of DOS File Extensions
2. List Files Using FILE UTILITIES
3. Copy, Rename and Delete Files Using FILE UTILITIES
4. Format, Label and List Contents of Disks Using DOS Commands
5. Copy, Rename, and Delete Files Using DOS Commands

L. PRODUCE PLOTTED COPIES OF DRAWINGS

1. Set up Plotter
   a. Load media
   b. Load pens
2. Set up Parameters Within a Drawing File for Plotting

M. USE LAYERS TO SEPARATE DETAILS OF A DESIGN

1. Name and Create Layers
   a. Select colors
   b. Set linetypes
2. Set Layers
3. Control Visibility of Layers
4. Lock Layers
5. Freeze Layers
6. Rename Layer

7. Edit Layer Properties

N. CREATE AND STORE SYMBOLS

1. Create and Save Blocks
2. Insert Blocks into a Drawing
3. Edit Blocks and Update Existing Insertions

O. DESCRIBE SIZE, SHAPE AND LOCATION OF DRAWING FEATURES WITH DIMENSIONS

1. Dimension Objects According to ANSI Standards
2. Identify and Set Variables to Control the Appearance of Dimensions
3. Add Linear, Angular, Diameter and Radius Dimensions to a Drawing
4. Set Units and Decimal Places
5. Apply Tolerances as Required

P. USE CAD SKILLS TO CREATE A DRAWING PROJECT RELATED TO STUDENT'S MAJOR

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. follows a schedule to complete assigned tasks on time
2. determine the appropriate media and instruments to complete assignments
3. provide a self-evaluation of performance based on the time and quality of work

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

1. complete assigned responsibilities within the course serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce drawings to acceptable levels of quality as required
4. works well with all members of the class

C. Information: Acquires and uses information

1. reads and interprets text and handouts
2. organizes and applies theories of drafting and design
3. applies lecture concepts to lab techniques

D. *Systems: Understands complex inter-relationships*
   1. demonstrates knowledge of the following systems:
      a. laboratory organization structure: physical and social
      b. organization of personnel and facilities in the computer drafting lab
      c. systematic approach to the drafting and design process
      d. dimensioning and measurement systems
      e. systematic organization of training materials
   2. monitors and corrects performance
      a. during the drawing process
      b. making adjustments to individual laboratory work schedules
      c. while constantly evaluating the quality of work to achieve acceptable standards
      d. though maintaining a record of evaluations
      e. to meet individual goals

E. *Technology: Works with a variety of technologies*
   1. chooses, procedures media and supplies required to produce a drawing
   2. applies appropriate procedures and uses appropriate tools and equipment to produce a drawing to acceptable standards
   3. maintains and troubleshoots equipment and tools
      a. applies appropriate preventative maintenance
      b. reports all malfunctions of equipment to supervisor/instructor
      c. performs clean-up assignments of lab

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. interprets technical drawings
      b. reads/studies concepts in textbook
      c. follows a daily laboratory schedule to maintain appropriate time-line to meet scheduled deadlines
      d. interprets concepts in texts to develop accurate drawings
   2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. outlines the steps necessary to produce a simple drawing
      b. sketches object to produce a final drawing
      c. maintains a schedule of assignments and deadlines (these may take the form of a chart, graph, etc.)
      d. maintains a lecture notebook
      e. submits written responses to chapter question assignments
      f. completes all written assignments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. bisects lines, circles, arcs and angles
   b. divides objects into equal parts
   c. applies tolerances
   d. applies and verify dimensions
   e. uses fraction and decimal values
   f. applies principles of trigonometry and geometry to solve angle calculations and tangencies and to define points
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilates concepts presented by lecture, video or any multimedia methods
   b. observes laboratory demonstrations for technique and safety instructions
   c. seeks and receive individualized instruction in the laboratory
   d. actively listens and participates in discussions and question/answer sessions
5. *Speaking: Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organizes ideas and communicates specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the efficient and safe completion of assignments

B. *Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reason.*
1. *Decision Making: Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. identifies personal goals
   b. prioritizes goals
   c. identifies specific actions required to accomplish personal goals
   d. allows for flexibility in meeting goals as circumstances change
2. *Problem Solving: Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. understands both written and verbal instructions
   b. assimilates process during instructor demonstrations

c. interprets technical drawings
d. interprets technical illustrations and symbols
e. interprets and applies geometric construction concepts

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrates mastery of the basic skills and techniques
   b. uses these sequential skills to support mastery of new skills
   c. consistently applies the sequential nature of acquired skills to the subsequent knowledge application of new skills and techniques

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice will improve the skill of the technician
   b. understands that the quality of the product is a function of time spent and the attitude and skill of the technician

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. attends class as scheduled and is well prepared for the day's work
   b. completes assignments independently and on time
   c. works well within a team while completing individual assignments

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assists classmates in improving technical skills
   b. assists students with special needs as a peer mentor
   c. shares laboratory resources (computers, plotters and instructor's individual attention)

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. performs in-process quality checks on CAD drawings
   b. maintains a record of academic achievement (individual gradebook)
   c. maintains a schedule of deadlines, due dates, and other important dates (calendar)
   d. adjusts calendar to accommodate unexpected circumstances
   e. accepts the responsibility for self management

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. accepts responsibility for own actions
   b. exhibits personal honesty at all times
   c. accepts the challenge of doing his/her own work in the laboratory, during examination and on outside assignments
   d. understands the consequences of unethical behaviors

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*T*echnology Program

MAST

COURSE SYLLABUS

CAD/CAM II

Prerequisite: CAD/CAM I

MAST PROGRAM
COURSE SYLLABUS
CAD/CAM II

Lecture hours/week: 3 **Lab hours/week: 3** **Credit hours: 4**

COURSE DESCRIPTION:

A continuation of CAD/CAM I with advanced utilization of "SMARTCAM". Topics will include the following: 3-D Process Modeling, creation and utilization of different work planes, 4th and 5th axis programming, creation of tool path for surface primitives, swept surfaces, translated surfaces, sculpted surfaces, ruled surfaces, and coons surfaces. Additional topics include: projecting, intersecting, blending, and trimming one surface to another surface. Students will program both a simple punch and die set and a simple injection mold cavity.

PREREQUISITES: **CAD/CAM I**

REQUIRED COURSE MATERIALS:

Textbook: SMARTCAM-3D, Pelton, TSTC Pub., 2nd Ed.
Lab Manual: **NONE**

Materials and/or Supplies: 2 - double sided, high density 3 ½" floppy diskettes

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, overheads and SMARTCAM and software demonstrations.

Laboratory: Laboratory will be a "hands-on" (computer based) process modeling "SMARTCAM" System.

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. demonstrate the comprehension of Work Plane and Plane Coordinates and the ability to change from one work plane to another work plane to perform work
2. demonstrate the ability to construct surface boundaries on various work planes
3. demonstrate the ability to both identify and create various surfaces which are available in the SMARTCAM 3-D system to include:
   Surface Primitives: Plane, Cone, Cylinder, Sphere, Toris
   Composite Surfaces: Spun, Translated, Ruled, Lofted, Form Patch, Coons
4. generate tool path in both the generator, radial and planar directions
5. develop tool path geometry and part geometry to produce accurately coded information for 3-D CNC mill parts

6. demonstrate the 3-D techniques of projection, intersection, surface trim and blend
7. utilize plotters and printers to produce accurate documents
8. perform and demonstrate the ability to transfer CAD files to CAM files and CAM files to CAD files
9. generate a tool path from CAD to CAM files
10. edit a tool path from a CAD file and proof the tool path from a CAD file
11. satisfactorily perform on written, oral, and practical examinations
12. satisfactorily perform on outside assignments including writing assignments
13. contribute to class discussions
14. maintain attendance per current policy

LECTURE OUTLINE:

	Lecture Topics	Text Reference Page	Contact Hrs.
Unit 1	**Understanding 3-D Parts**	**1-9**	
1.01	Coordinate Systems in SMARTCAM's Advanced 3-D Machining	1	
1.02	Choosing Active Work Planes	4	
1.03	World vs. Local Coordinate Inputs	4	
1.04	Working with Geometry on Work Planes	6	
1.05	Planning and Creating the 3-D Model	7	
Unit 2	**Surface Primitives**	**9-11**	
2.01	Understanding Surfaces	9	
2.02	Types of Surfaces	10-11	
2.02.1	Plane	10-11	
2.02.2	Cone	10-11	
2.02.3	Cylinder	10-11	
2.02.4	Sphere	10-11	
2.02.5	Toris	10-11	
Unit 3	**Composite Surfaces**	**12**	
3.01	Spun Surfaces	12	
3.02	Translated Surfaces	12	
3.03	Ruled Surfaces	12	
	Review for Quiz 1		
	QUIZ 1		
Unit 4	**Sculpted Surfaces**	**13-14**	
4.01	Lofted Surfaces	13	
4.02	Form Patch Surfaces	13-14	
4.03	Coons Surfaces	14	
Unit 5	**Modeling 3-D Surface Toolpaths**		
5.01	Expert Tips for Model Construction		
5.02	Using Wireframe Geometry for Surface E Definition		
5.03	Creating 3-D Surface Tool Paths		

5.04	Creating a Blend Surface	
5.05	Planar Cuts	
	Review for Quiz 2	
	QUIZ 2	
Unit 6	**Additional Modeling Practices**	
6.01	Projection	
6.02	Intersection	
6.03	Surface Trim and Blend	
6.04	Editing Surfaces	
	Review for Quiz 3	
	QUIZ 3	
	Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Understanding Work Planes	2
Surface Primitives	3
Composites Surfaces	2
Sculpted Surfaces	2
Process Modeling (Drawing)	24
a. Wax Block	
b. Pyramid	
c. Palace	
d. Round Punch	
e. Ruled Block	
f. Cross	
g. Round Die	
h. Shift Boot	
i. Fin	
j. Knobmold	
Final Project	3
Total Lab Hours	**36**

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
2. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
3. Interconvert Metric/English measurements

a. Convert English dimensions to Metric
b. Convert Metric dimensions to English
c. Use Metric/English conversion chart

4. Utilize Trigonometric Functions
   a. Solve for unknown angles
   b. Solve for unknown sides
5. Calculate Speeds and Feeds for Machining Using SMARTCAM's Job Plan Module
   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut
6. Locate Machining Points from a Datum Point
   a. Identify points using the Cartesian coordinate system
   b. Identify points using the absolute dimensioning system
   c. Identify points using the incremental dimensioning system
   d. Identify points using both world and local coordinate values

B. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify item number symbols
   c. Identify general note symbols
   d. List the essential components found in the title block
   e. Locate bill of materials in a drawing
   f. Identify the components found in the revision block
3. Identify Basic Types of Drawings
   a. Identify orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)
   c. Visualize one or more views from a given view
   d. Identify isometric views
   e. Identify exploded isometric drawings
   f. Identify assembly drawings
4. Verify Drawing Elements
   a. Determine the scale of the view or section
   b. Check for revisions
   c. Recognize out-of-date blueprints
5. Practice Geometric Dimensioning and Tolerancing (GD&T) Methodology
   a. Identify the purpose of GD&T
   b. Identify symbols for controlling location (or true position) of part features
   c. Identify symbols for controlling form (or alignment) of part features
   d. Identify symbols for showing datums and basic dimensions on drawings

e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)

6. Describe the Relationship of Engineering Drawings to Planning
   a. Discuss production schedule
   b. Discuss Material Resource Planning (MRP)
   c. Discuss inventory control records
   d. Utilize "SMARTCAM's" Job Plan to determine machine operations sequences
7. Analyze Bill of Materials (BOM)
   a. Discuss components found on BOM
   b. Determine materials needed to produce the part
   c. Determine quantities necessary to produce the part
   d. Submit completed stock request form as required
   e. Submit completed tool request form as needed

C. RECOGNIZE DIFFERENT MANUFACTURING MATERIALS AND PROCESSES

1. Determine Operations to be performed
   a. Identify workpiece material requirements
   b. Identify cutting tool material requirements speeds, feeds, depth of cuts
   c. Identify setup parameters, strength and ridigity of setup, strength and ridigity of the workpiece, power requirements, finish and tolerances, use of coolants
2. Sequence Machine Operations
   a. Utilize "SMARTCAM's" 3-D Modeling Tool
   b. Verify toolpath

COURSE OBJECTIVES: SCANS COMPETENCIES

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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. follows a schedule to complete assigned tasks on time
   2. provide a self-evaluation of performance based on the time and quality of work

B. Interpersonal: Works with others
   1. complete assigned responsibilities within the laboratory serving as a member of the team

2. provide individual assistance/direction to peers as requested
3. works well with all members of the class

C. *Information: Acquires and uses information*
1. read and interpret blueprints
2. organize and apply theories of machine tool operation

D. *Systems: Understands complex inter-relationships*
1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. systematic approach to the metal removal process
   c. dimensioning and measurement systems
   d. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

E. *Technology: Works with a variety of technologies*
1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards

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. studies student laboratory manual
   b. interprets blueprints and technical drawings
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion
2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a simple machine part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. complete all written assignments
3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum machining speeds, feeds, and depth of cut
   b. calculates "value added to the part"
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction

c. observe laboratory demonstrations
d. seek and receive individualized instruction in the laboratory

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
   b. identifies actions required to accomplish personal goals

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the technician
   b. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters 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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work

c. develops an understanding good students know what they are going to do in class and does not waste time
d. develops a fine work-ethic

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual gradebook)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. SMARTCAM Advanced 3-D Machining Reference Manual
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers
3. Machine Tool Catalogs

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

MAST

COURSE SYLLABUS

MOLD MAKING II

Prerequisite: MOLD MAKING I

MAST PROGRAM
COURSE SYLLABUS
MOLD MAKING II

Lecture hours/week: 3 **Lab hours/week: 9** **Credit hours: 6**

COURSE DESCRIPTION:

This course is designed to help students progress from the basics of mold making to more intermediate topics and skills. This course will focus on the setup and operation of the sinker electrical discharge machine (EDM). In addition, this course will improve the students basic skills of mold stoning and polishing. More advanced topics in mold design and machine tool operation as related to mold making will be covered.

PREREQUISITES: **Mold Making I**

REQUIRED COURSE MATERIALS:

Textbook: Injection Molds and Molding, by Joseph B. Dym
Lab Manual: **NONE**

Hand Tools/Quantity Required:

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures, handouts, and demonstrations.

Laboratory: Laboratory will consist of "hands on" activities which will enable the student to learn the necessary basic skills to operate electrical discharge machines and make plastic injection molds.

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.
EDM Safety Practices		2
Discuss the EDM process		2
List advantages and disadvantages of the EDM process		2
Identify electrode materials		2
Calculate overburn		2
Standard Mold Design		14
Machining Methods		6
Support Pillars		2
Support Plates		2
Ejection System		2
	Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Set Up and Operate Sinker EDM	12
Manufacture Electrodes to Produce a Work Piece	12
Roughers and Finishers	
Demonstrate proper electrode mounting techniques	4
Utilize 3R tooling	4
Perform touch-off procedures	6
Adjust for optimum machine operation	4
Make generator setting	4
Choose proper techniques for flushing	4
Perform continuity checks	4
Determine R-MAX finish required	4
Setup and operate wire cut EDM machines	6
Stone and Polish Steel Surfaces to a Pre-Determined Finish	16
Machine Support Plates	6
Manufacture Ejection System	10
Machine Mold Pockets	12
Total Lab Hours	**108**

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. Assume responsibility for the personal safety of oneself and others
   - b. Develop a personal attitude towards safety
   - c. Interpret safety manual directives
   - d. Comply with established company safety practices
2. Use Protective Equipment

a. Wear protective safety clothing as required
b. Maintain and use protective guards and equipment on machinery
c. Locate and properly use protective equipment
d. Use lifting aids when handling molds or other heavy materials (e.g., eye bolts, slings, cables)

3. Debur Mold Bases to Help Avoid Cuts
   a. Chamfer outside edges of mold bases
   b. Do not debur parting edges of mold cavities, runners, gates, etc.
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Keep machine and hand tools clean at all times
   c. Put tools away when not in use
   d. Keep aisles clear of equipment and materials

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
2. Locate Machining Points from a Datum Point
   a. Identify points using the Cartesian coordinate system
   b. Identify points using the polar coordinate system
   c. Identify points using the absolute dimensioning system
   d. Identify points using the incremental dimensioning system
   e. Identify reasons for establishing datum point in the center of the mold base
3. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
4. Interconvert Metric/English measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
5. Perform Basic Trigonometric Functions
   a. Solve for unknown angles
   b. Solve for unknown sides
   c. Calculate for bolt circles
6. Use Sine Bar or Sine Plate for Machine Operations
   a. Use trigonometric tables for solutions
   b. Use calculator for solutions
   c. Calculate gage block build up
7. Calculate Draft Angles
   a. Discuss reason for draft in the mold
   b. Discuss recommended draft angles for various molding processes
   c. Use D-M-E table to determine draft angles for parts of different thickness
8. Calculate Runner Size for Molding
   a. Calculate optimum runner diameter
   b. Calculate optimum runner length

9. Apply "Shrink Rate" Formulas
   a. Discuss shrink figures for various thermoplastic materials
   b. Discuss causes for shrink rate variations
   c. Apply shrink rate formulas to mold design
10. Calculate Speeds and Feeds for Machining
   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut

C. **INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS**

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify item number symbols
   c. Identify general note symbols
   d. List the essential components found in the title block
   e. Locate bill of materials in a drawing
   f. List the components found in the revision block
3. Identify Basic Types of Drawings
   a. Identify orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)
   c. Visualize one or more views from a given view
   d. Identify isometric views
   e. Identify exploded isometric drawings
   f. Identify assembly drawings
4. List the Purpose of Each Type of Drawing
   a. Discuss purpose of orthographic (3 views) drawings
   b. Discuss purpose of isometric drawing
   c. Discuss purpose of exploded isometric drawing
   d. Discuss purpose of assembly drawings
5. Verify Drawing Elements
   a. Determine the scale of the view or section
   b. Check for revisions
   c. Recognize out-of-date blueprints
6. Identify Lines and Symbols (GD&T)
   a. Discuss the reason for GD&T
   b. Identify symbols for controlling location (or true position) of part features
   c. Identify symbols for controlling form (or alignment) of part features
   d. Identify symbols for showing datums and basic dimensions on drawings

e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)

7. Describe the Relationship of Engineering Drawings to Planning
   a. Discuss production schedule
   b. Discuss Material Resource Planning (MRP)
   c. Discuss inventory control records
   d. Discuss shop floor routing documents
8. Use Standards to Verify Requirements
   a. Discuss the purpose of standards
   b. Discuss source locations for standards
9. Analyze Bill of Materials (BOM)
   a. Discuss components found on BOM
   b. Discuss components found in parts lists
10. Create Technical Sketches
   a. Discuss the value of sketching as a communication tool
   b. Describe basic orthographic sketching techniques
   c. Describe basic isometric sketching techniques
   d. Draw a sketch of a machine part

D. SELECT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
   a. Discuss classification system for metals
   b. Discuss general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals
2. Identify Heat Treating Processes
   a. Discuss the reasons for heat treating
   b. Discuss the time/temperature chart
   c. List the different quenching mediums
   d. Estimate metal heat temperature by color
   e. Discuss purpose of normalizing
   f. Discuss purpose of annealing
   g. Discuss purpose of stress relieving
   h. Discuss purpose of hardening
   i. Discuss purpose of tempering
   j. Discuss purpose of nitriding
3. Identify Plastic Molding Processes
   a. Describe the blow molding process
   b. Describe the vacuum forming process
   c. Describe the injection molding process
   d. Describe the reaction injection molding process
   e. Describe the extrusion molding process
   f. Describe the compression molding process
   g. Describe the transfer molding process
   h. Describe the rotational molding process
   i. Discuss the advantages of using composites
   j. Describe the composite molding methods
4. Identify Types of Mold Steels
   a. Discuss mold service requirements

b. Discuss mold hardness requirements
c. Discuss machinability of mold steel
d. Describe P-20, Plastic Mold Steel
e. Describe A-2, Cold Work Tool Steel
f. Describe S-1, Shock Resisting Tool Steel
g. Describe H-13, Chromium type Hot Work Tool Steel
h. Describe S-7, Shock Resisting Tool Steel
i. Describe Type 414, Stainless Plastic Mold Steel
j. Describe Type 420, Stainless Plastic Mold Steel

E. PERFORM MEASUREMENT/INSPECTION

1. Identify Types of Measurement
   a. Distinguish between direct and calculated measurements
   b. Compute calculated measurements
   c. Justify the use of precision measurements in manufacturing
   d. Discuss the following: precision, reliability and accuracy
   e. Demonstrate general measurement techniques
   f. Demonstrate semi-precision measurement techniques
   g. Demonstrate precision measurement techniques
   h. Document results of measurement activities and calculations
2. Select Proper Measurement Tools
   a. Match appropriate measurement tools with various types of measurement requirements
   b. Demonstrate proper measurement tool usage
   c. List steps of proper measurement
   d. Explain rationale for each step
   e. Identify error possibilities in measurement tool selection
   f. Identify error possibilities within measurement procedures
   g. Identify common conversion error possibilities
   h. Discriminate between accepted measurement procedures and improper measurement procedures
3. Apply Proper Measuring Techniques
   a. Explain calibration requirements of various precision instruments
   b. Illustrate measurement differences when taken with calibrated and non-calibrated instruments
   c. Justify use of particular measurement tools based on tool characteristics
   d. Discuss factors affecting accurate measurement (dirt, temperature, etc.)
4. Measure With Hand Held Instruments
   a. Measure with steel rules (metric and inch)
   b. Measure with micrometers
   c. Measure with comparison measuring instruments (e.g., calipers, telescope gages, etc.)
   d. Measure with direct measuring instruments (e.g., vernier, dial, and digital instruments)
   e. Measure with fixed gages (go and not go gages)
5. Measure/Layout/Inspect Using Surface Plate
   a. Describe and properly use surface plate
   b. Use surface plate accessories correctly (sine bar, gage blocks, etc.)

c. Check for part squareness
d. Check part dimensions for accuracy
e. Align workpieces using height gage and dial indicators

F. PERFORM CONVENTIONAL MACHINING OPERATIONS

1. Prepare and Plan For Machining Operations
   a. Read and interpret blueprints
   b. Perform basic semi-precision and precision layout as necessary
   c. Plan machining operations
   d. Understand machinability and chip formation
   e. Calculate speeds, feeds, and depth of cut for various machine applications
   f. Use carbides and other tool materials to increase productivity
   g. Use the Machinery's Handbook as a reference for machine applications
2. Use Proper Hand Tools
   a. Use arbor and shop presses
   b. Select necessary work-holding devices and hand tools as needed
   c. Select and use hand files
   d. Identify and use hand reamers
   e. Correctly identify and use hand taps as required
   f. Follow tapping procedures to produce internal threads
   g. Use thread-cutting dies to produce external threads
   h. Operate bench and pedestal grinders safely
3. Operate Power Saws
   a. Use reciprocating and horizontal band cutoff machines
   b. Operate abrasive and cold saws
   c. Prepare and use the vertical band saw
   d. Weld a bandsaw blade
4. Operate Drill Presses
   a. Describe the different types of drill presses found in the machine shop
   b. Describe and use standard drilling tools
   c. Sharpen a drill bit using a bench or pedestal grinder
   d. Setup the drill presses for drilling, countersinking, counterboring, reaming, and tapping operations
   e. Drill holes using drill jigs
5. Operate Vertical Milling Machines
   a. Demonstrate the use of all controls on the vertical milling machine
   b. Align the vertical milling machine head
   c. Select, align and use workholding devices
   d. Select milling tool holders
   e. Select milling cutters
   f. Perform all standard vertical milling operations
   g. Bore a hole using the offset boring head
   h. Machine angles using sine bar and gage blocks
   i. Setup and use special vertical mill fixtures
   j. Setup and machine dovetails
   k. Machine keyways
6. Operate Horizontal Milling Machines
   a. Discuss the difference in plain and universal horizontal milling machines

b. Discuss the types of spindles, arbors and adaptors used on the horizontal milling machine
c. List several common work holding methods
d. Use plain milling cutters
e. Use side milling cutters
f. Use face milling cutters
g. Setup and use special horizontal mill fixtures

7. Operate Metal Cutting Lathes
   a. Demonstrate the use of all controls on the engine lathe
   b. Discuss standard tools and toolholders for the lathe
   c. Face and center drill parts correctly
   d. Drill, ream and bore on the lathe
   e. Turn between centers
   f. Discuss alignment of lathe centers
   g. Make all calculations, lathe adjustments and settings to machine sixty-degree internal and external threads
   h. Discuss thread fit classifications
   i. Make all calculations, lathe adjustments and settings to machine Acme threads
   j. Describe the common tapers used in the machine shop
   k. Discuss taper cutting and calculations for the lathe
   l. Setup and use the taper attachment found on most lathes
   m. Use follower rests and steady rests
   n. Use HSS cutting tools
   o. Use carbide cutting tools
   p. Setup and operate tracer lathes
   q. Setup and operate turret lathes
8. Operate Grinding/Abrasive Machines
   a. Discuss the selection and identification of grinding wheels
   b. Inspect, mount, true, dress, and balance grinding wheels
   c. True table by indicator
   d. True back rail by indicator
   e. Make the form in the wheel
   f. Check the form in the wheel
   g. Discuss the selection of grinding fluids
   h. Operate horizontal spindle reciprocating table surface grinders
   i. Operate cylindrical grinders
   j. Operate ID and OD grinders
   k. Setup and operate tool and cutter grinders
   l. Discuss common problems and solutions in surface grinding
   m. Operate honing machine
   n. Operate lapping machines
9. Operate Deburring Equipment
   a. Debur parts using pneumatic Deburring tools
   b. Debur parts using electric deburring tools
10. Polish Mold Cavities
   a. Discuss finish requirements of molds

b. Discuss surface finish symbols
c. Select abrasive for mold finishing
d. Describe steps for achieving "mirror" finish
e. Describe molding problems related to poor surface conditions

G. PERFORM ADVANCED MACHINING PROCESSES

1. Operate Electrical Discharge Machines
   a. Discuss the EDM process
   b. List advantages and disadvantages of the EDM process
   c. Identify electrode materials
   d. Machine EDM electrodes
   e. Setup and operate die sinker EDM machines
   f. Calculate overburn
   g. Identify generator setting of machine
   h. Choose proper techniques for flushing
   i. Estimate number of roughers and finishers
   j. Demonstrate proper electrode mounting techniques
   k. Utilize 3R tooling
   l. Perform touch-off procedures
   m. Recognize optimum machine settings
   n. Perform continuity checks
   o. Determine R-MAX finish required
   p. Setup and operate wire cut EDM machines

H. BUILD/REPAIR/MODIFY MOLDS

1. Identify Types of Molds (e.g., three plate, multi-cavity, cam action, hot runner)
   a. Identify/describe three plate mold
   b. Identify/describe multi-cavity molds
   c. Identify/describe runnerless molds
   d. Identify/describe cam action molds
2. Identify Typical Mold Components (e.g., cavity and core insert, ejector mechanisms, etc.)
   a. Identify/describe cavity inserts
   b. Identify/describe core inserts
   c. Describe engraving inserts
   d. Identify/describe ejector pins, blades and ejector plates
   e. Identify/describe stripper plates and rings
   f. Discuss and/or install compressed air ejector systems
3. Estimate Basic Mold Cost Considerations (e.g., engineering, material, labor)
   a. Discuss factors relating to molding process (high vs. low pressure)
   b. Discuss factors relating to molding material (hard vs. easy flow)
   c. Discuss factors relating to volume
   d. Discuss factors relating to part size
   e. Discuss factors relating to part complexity
   f. Discuss factors relating to part tolerances
4. Apply Basic Mold Design: Principles (nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs)
   a. Describe types of runner systems (e.g., full, half, quarter, trapezoidal, and modified trapezoidal)

b. Describe laminar and turbulent flow
c. Discuss the purpose of cold slug extensions
d. Discuss recommended runner size for various materials
e. Discuss common gate types (e.g., jump, tunnel, tab, ring, sprue, center, fan)
f. Discuss mold venting (e.g., location, size, solutions)
g. Discuss wall thickness
h. Discuss part radius considerations
i. Discuss rib design and placement
j. Discuss draft angles

5. Install Mold Temperature Control Devices
   a. Describe mold baffles
   b. Describe mold bubblers
   c. Describe design of water line placements
   d. Discuss mold cooling problems
6. Disassemble/Assemble Molds
   a. Completely disassemble a mold base
   b. Identify all components
   c. Assemble mold base to working condition
7. Identify "Off the Shelf" Mold Components
   a. Identify sources of molding components
   b. Use catalogues to order components for mold construction
8. Construct a Cavity and Core for an Injection Mold
   a. Machine a cavity for a mold
   b. Machine a core for a mold
   c. Install the components into the mold
   d. Check for proper mold operation
9. Build/Assemble/Adjust Ejector Plates and Pins
   a. Select proper type of ejector mechanism
   b. Determine size and placement of ejectors
   c. Locate, drill and assemble ejector plate w/ejector pins
   d. Assemble, measure, and final grind ejector lengths for proper clearance
   e. Check final operation of ejector mechanism
10. Vent Molds
   a. Determine mold vent requirements
   b. Determine mold size requirements
   c. Determine optimum mold locations
   d. Machine vent openings
   e. Hand finish vent to cavity openings
   f. Check final operation for "flash" and proper mold filling
11. Perform Preventative Maintenance (e.g., mold cleaners, mold releases, rust preventatives)
   a. Select/use mold cleaners
   b. Select/use mold releases
   c. Select/use rust preventatives
   d. Use "soft tools" around mold cavities

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. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
3. provide a self-evaluation of performance based on the time and quality of work

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

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. machine mold components to acceptable levels of quality as required
4. works well with all members of the class

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

1. read and interpret blueprints
2. organize and apply theories of mold design and construction

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

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the mold design and construction
   d. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

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

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a molded part to acceptable standards
3. maintains and troubleshoots equipment

a. applies appropriate preventative maintenance
b. when operating machines
c. reports all malfunctions of equipment to supervisor/instructor
d. perform clean-up assignments of machine and shop floor at the end of the laboratory

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. studies student laboratory manual
b. interprets molding machine manuals
c. read/studies textbook
d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

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

a. maintain a lecture notebook
b. submit written responses to chapter question assignments
c. complete all written assignments

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

a. determines optimum mold design parameters for various plastic polymers
b. calculates "value added to the part"
c. adjusts machine parameters to achieve a quality part

*4. **Listening:** Receives, attends to, interprets, and responds to verbal messages and other cues*

a. assimilate classroom instruction
b. interpret and assimilate video instruction
c. observe laboratory demonstrations
d. seek and receive individualized instruction in the laboratory

*5. **Speaking:** Organizes ideas and communicates orally*

a. participates in classroom discussions
b. organize ideas and communicate specific questions to the instructor
c. verbally affirms understanding of a concept, procedure, or required skill
d. communicates with peers to ensure the smooth and safe operation of the laboratory

*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. identifies personal goals

b. identifies actions required to accomplish personal goals

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the technician
   c. understands the relationship between different plastic materials and mold design variables and makes adjustments as necessary

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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Moldmaking and Die Cast Dies for Metalworking Trainees, by John Kluz. National Tooling and Machining Association.

MET309
01/072496

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

MAST

COURSE SYLLABUS

STRENGTH OF MATERIALS

MAST PROGRAM
COURSE SYLLABUS
STRENGTH OF MATERIALS

Lecture hours/week: 3 **Lab hours/week: 3** **Credit hours: 4**

COURSE DESCRIPTION:

This is a course designed to give the student a basic understanding of the internal stresses and deformation of elastic bodies resulting from the action of external forces. The student should be able to: determine internal stresses due to external loads, make calculations for riveted joints with specified loads, analyze welded joints, determine the centroid and moment of inertia of a built-up section.

PREREQUISITES: **Statics**

REQUIRED COURSE MATERIALS:

Textbook: Applied Statics and Strength of Materials, Spiegel and Limbunner, Merrill Publishers
Lab Manual: NONE

Required Materials: Engineering paper, green
Scientific Calculator

METHODS OF INSTRUCTION:

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

Laboratory: Laboratory assignments will require student to solve appropriate problems involving the mechanical and physical properties of various materials.

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

LECTURE OUTLINE:

	Lecture Topics	Text Reference Page	Contact Hrs.
1	**Centroids and Centers of Gravity** (Review from MET 205)		
.01	Center of Gravity	182	
1.02	Centroids and Centroidal Axes	185	
1.03	Centroids and Centodial Axes of Composite Areas	186	
2	**Area Moments of Inertia**		
2.01	Terms and Definitions	201	
2.02	Moments of Inertia	203	
2.03	The Transfer Formula	207	
2.04	Moments of Inertia of Composite Areas	208	
2.05	Radius of Gyration	216	
2.06	Polar Moment of Inertia	218	
2.07	Chapter Review	221	
3	**Stresses and Strains**		
3.01	Tensile and Compressive Stresses	227	
3.02	Shear Stresses	234	
3.03	Tensile and Compressive Strain and Deformation	239	
3.04	Shear Strain	241	
3.05	The Relationship Between Stress and Strain (Hooke's Law)	242	
3.06	Chapter 9 Summary	249	
4	**Torsion in Circular Sections**		
4.01	Introduction	316	
4.02	Torsional Shear Stress	320	
4.03	Angle of Twist	328	
4.04	The Transmission of Power by Shafts	332	
4.05	Chapter 12 Summary	336	
5	**Shear and Bending Moments in Beams**		
5.01	Types of Beams and Supports	343	
5.02	Types of Loads on Beams	346	
5.03	Beam Reactions	347	
5.04	Shear Force and Bending Moments	352	
5.05	Shear Diagrams	360	
5.06	Moment Diagrams	371	
5.07	Sections of Maximum Moment	377	
5.08	Moving Loads	381	
5.09	Chapter 13 Summary	385	
6	**Stresses in Beams**		
6.01	Tensile and Compressive Stresses Due to Bending	395	
6.02	The Flexure Formula	397	
6.03	Computation of Bending Stresses	401	
6.04	Shear Stresses	407	

LAB OUTLINE:

Lab Topics	Contact Hrs.
Area Moments of Inertia (Chapter 8, Problems 1, 2, 7, 9, and 22)	4
Stresses and Strains (Chapter 9, Problems 2, 4, 7, 8, 12, 13, 14, 16, 25, and 28)	8
Torsion in Circular Sections (Chapter 12, Problems 1-6, 11, 12, 14, and 24)	8
Shear and Bending Moments in Beams (Chapter 13, Problems 2, 4, 6, 10, 12, 13, 15, 16, 17, and 18)	8
Stresses in Beams (Chapter 14, Problems 3, 5, 8, 9, 11, 15, and 32)	4
Design of Beams (Chapter 15, Problems 2, 4, 5, 6, and 12)	4
Total Lab Hours	**36**

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. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Interpret safety manual directives
   d. Comply with established company safety practices
2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when necessary
3. Follow Safe Operating Procedures for Hand and Machine Tools
   a. Identify and understand safe machine operating procedures
   b. Demonstrate safe machine operation
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Clean machine/hand tools when work is completed
   c. Put tools away when work is finished

d. Keep aisles clear of equipment and materials

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
2. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
3. Interconvert Metric/English measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
4. Perform Basic Trigonometric Functions
   a. Solve for unknown angles
   b. Solve for unknown sides
5. Solve Static Systems for Resultant Forces
   a. Solve for the following coplanar force systems: parallel, concurrent and nonconcurrent
   b. Solve for the following noncoplanar force systems: parallel, concurrent and nonconcurrent
6. Solve Engineering Equations
   a. Solve linear algebraic equations for an unknown
   b. Solve a system of linear equations with two unknowns
   c. Solve right triangles for unknown sides or angles
   d. Use the law of sines and cosines to solve obtuse triangles with unknown sides and angles
   e. Calculate factors of friction
7. Use All Functions of a Scientific Calculator
   a. Apply all trigonometric functions
   b. Apply all algebraic functions
   c. Apply all statistical functions
8. Determine Strengths of Materials for Various Applications
   a. Discuss stress and deformation
   b. List properties of materials (e.g., strength, elasticity, stiffness, ductility, hardness)
   c. Calculate stresses and design of joints
   d. Discuss advantages and disadvantages of different fastening technique
   e. Discuss problems related to torque-twisting moments
   f. Discuss centroids and moments of inertia of areas

C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print

e. Interpret commonly used abbreviations and terminology
f. Determine tolerances associated with dimensions on a drawing
g. Determine the tolerance for a reference dimension
h. Determine the surface finish for a given part
i. List the essential components found in the general drawing notes

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C. Information: Acquires and uses information
1. read and interpret blueprints
2. organize and apply theories of machine tool operation

D. Systems: Understands complex inter-relationships
1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the metal removal process
   d. dimensioning and measurement systems
   e. systematic organization of training materials
2. monitors and corrects performance during
   a. application of statics principles and structural analysis
   b. adjustments of individual laboratory work schedule

c. constantly evaluating the quality of work to achieve acceptable standards
d. maintains record of evaluations and sets individual goals

E. ***Technology:*** *Works with a variety of technologies*
1. uses a scientific calculator
2. applies appropriate procedures and uses appropriate hardware and software

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. studies student laboratory manual
b. interprets blueprints and technical drawings
c. read/studies textbook
d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
a. outline the steps necessary to produce a simple machine part
b. maintain a lecture notebook
c. submit written responses to chapter question assignments
d. complete all written assignments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
a. determines optimum machining speeds, feeds, and depth of cut
b. calculates "value added to the part"
c. aligns machine and/or work holding device
d. taps and threads
e. keeps a running computation of individual grade
f. interconverts fractions to decimal expressions
g. use protractors to lay-out angle machining
h. use trigonometry to solve angle and taper calculations

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
a. assimilate classroom instruction
b. interpret and assimilate video instruction
c. observe laboratory demonstrations
d. seek and receive individualized instruction in the laboratory

5. ***Speaking:*** *Organizes ideas and communicates orally*
a. participates in classroom discussions
b. organize ideas and communicate specific questions to the instructor
c. verbally affirms understanding of a concept, procedure, or required skill

d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the machinist
   c. understands the relationship between different materials and the principles of statics and mechanics applied to these materials

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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. learns to take pride in his or her work through positive reinforcement
b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Machinery's Handbook, Industrial Press
2. Applied Statics and Strength of Materials, Spiegel and Limbunner, Merrill Publishers

MET312
01/072396

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

MAST

COURSE SYLLABUS

CAD/CAM III

Prerequisite: CAD/CAM II

MAST PROGRAM
COURSE SYLLABUS
CAD/CAM III

Lecture hours/week: 2 **Lab hours/week: 6** **Credit hours: 4**

COURSE DESCRIPTION:

A continuation of CAD/CAM II with advanced utilization of "SMARTCAM". Advanced topics will include the following: 3-D Process Modeling, creation and utilization of different work planes, 4th and 5th axis programming, creation of tool path for surface primitives, swept surfaces, translated surfaces, sculpted surfaces, ruled surfaces, and coons surfaces. Additional advanced topics include: projecting, intersecting, blending, and trimming one surface to another surface. Emphasis will be placed on programming CNC turning centers and CNC Electrical Discharge Machines (EDM). Most laboratory exercises will focus on CAD/CAM programming for the mold making option; therefore most live work will consist of injection and other plastic molding projects.

PREREQUISITES: **CAD/CAM II**

REQUIRED COURSE MATERIALS:

Textbook: **NONE**
Lab Manual: **NONE**

Materials and/or Supplies: 2 - double sided, high density 3 ½" floppy diskettes

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, overheads and SMARTCAM and software demonstrations.

Laboratory: Laboratory will be a "hands-on" (computer based) process modeling "SMARTCAM" System.

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 Topic	Text Reference Page	Contact Hrs.
Unit 1	**Advanced 3-D CNC Milling Exercises**		**4**
	Quiz 1		
Unit 2	**Advanced 3-D CNC Turning Exercises**		**4**
	Quiz 2		
Unit 3	**CNC Electrical Discharge Machine Programming**		**8**
	Quiz 3		
Unit 4	**Advanced CNC Molding Techniques**		**8**
	Quiz 4		
		Total Lecture Hours	**24**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Labs will be structured by the instructor to incorporate "live projects" and take advantage of the type of CNC equipment which is available at the college. Emphasis for this course will be "hands on" activities. The primary objective is for the students to be as confident making parts on CNC machines as they are on conventional machines.	
Total Lab Hours	**36**

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
2. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
3. Interconvert Metric/English measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
4. Utilize Trigonometric Functions
   a. Solve for unknown angles

b. Solve for unknown sides

5. Calculate Speeds and Feeds for Machining Using SMARTCAM's Job Plan Module
   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut
6. Locate Machining Points from a Datum Point
   a. Identify points using the Cartesian coordinate system
   b. Identify points using the absolute dimensioning system
   c. Identify points using the incremental dimensioning system
   d. Identify points using both world and local coordinate values

B. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify item number symbols
   c. Identify general note symbols
   d. List the essential components found in the title block
   e. Locate bill of materials in a drawing
   f. Identify the components found in the revision block
3. Identify Basic Types of Drawings
   a. Identify orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)
   c. Visualize one or more views from a given view
   d. Identify isometric views
   e. Identify exploded isometric drawings
   f. Identify assembly drawings
4. Verify Drawing Elements
   a. Determine the scale of the view or section
   b. Check for revisions
   c. Recognize out-of-date blueprints
5. Practice Geometric Dimensioning and Tolerancing (GD&T) Methodology
   a. Identify the purpose of GD&T
   b. Identify symbols for controlling location (or true position) of part features
   c. Identify symbols for controlling form (or alignment) of part features
   d. Identify symbols for showing datums and basic dimensions on drawings
   e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)
6. Describe the Relationship of Engineering Drawings to Planning
   a. Discuss production schedule
   b. Discuss Material Resource Planning (MRP)

c. Discuss inventory control records
d. Utilize "SMARTCAM's" Job Plan to determine machine operations sequences

7. Analyze Bill of Materials (BOM)
   a. Discuss components found on BOM
   b. Determine materials needed to produce the part
   c. Determine quantities necessary to produce the part
   d. Submit completed stock request form as required
   e. Submit completed tool request form as needed

C. RECOGNIZE DIFFERENT MANUFACTURING MATERIALS AND PROCESSES

1. Determine Operations to be performed
   a. Identify workpiece material requirements
   b. Identify cutting tool material requirements speeds, feeds, depth of cuts
   c. Identify setup parameters, strength and ridigity of setup, strength and ridigity of the workpiece, power requirements, finish and tolerances, use of coolants
2. Sequence Machine Operations
   a. Utilize "SMARTCAM's" 3-D Modeling Tool
   b. Verify Toolpath

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. follows a schedule to complete assigned tasks on time
   2. provide a self-evaluation of performance based on the time and quality of work

B. Interpersonal: Works with others
   1. complete assigned responsibilities within the laboratory serving as a member of the team
   2. provide individual assistance/direction to peers as requested
   3. works well with all members of the class

C. Information: Acquires and uses information
   1. read and interpret blueprints
   2. organize and apply theories of machine tool operation

D. *Systems: Understands complex inter-relationships*
   1. demonstrate knowledge of the following systems:
      a. laboratory organization structure: physical and social
      b. systematic approach to the metal removal process
      c. dimensioning and measurement systems
      d. systematic organization of training materials
   2. monitors and corrects performance during
      a. the machining process
      b. adjustments of individual laboratory work schedule
      c. constantly evaluating the quality of work to achieve acceptable standards
      d. maintains record of evaluations and sets individual goals

E. *Technology: Works with a variety of technologies*
   1. chooses procedure, tools and equipment required to produce a part
   2. applies appropriate procedures and uses appropriate tools and equipment to produce a machined part to acceptable standards

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. studies student laboratory manual
      b. interprets blueprints and technical drawings
      c. read/studies textbook
      d. follow a daily laboratory schedule to maintain appropriate time-line and product completion
   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. outline the steps necessary to produce a simple machine part
      b. maintain a lecture notebook
      c. submit written responses to chapter question assignments
      d. complete all written assignments
   3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
      a. determines optimum machining speeds, feeds, and depth of cut
      b. calculates "value added to the part"
   4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
      a. assimilate classroom instruction
      b. interpret and assimilate video instruction
      c. observe laboratory demonstrations
      d. seek and receive individualized instruction in the laboratory
   5. ***Speaking:*** *Organizes ideas and communicates orally*
      a. participates in classroom discussions
      b. organize ideas and communicate specific questions to the instructor

c. verbally affirms understanding of a concept, procedure, or required skill

d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the technician
   b. understands the relationship between different metals and the tool applied to the metal surface and adjusts machining parameters 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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. learns to take pride in his or her work through positive reinforcement
b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual gradebook)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. SMARTCAM Advanced 3-D Machining Reference Manual
2. Technology of Machine Tools, 4th Ed. McGraw Hill Publishers
3. Machine Tool Catalogs

MET406
01/072496

Machine Tool Advanced Skills Technology Program

MAST

COURSE SYLLABUS

MOLD MAKING III

Prerequisite: MOLD MAKING II

MAST PROGRAM
COURSE SYLLABUS
MOLD MAKING III

Lecture hours/week: 3 **Lab hours/week: 8** **Credit hours: 6**

COURSE DESCRIPTION:

This course is designed to give students experience with some of the more advanced skills required for mold makers. Topics covered will include: heat treatment equipment and procedures, advanced grinding techniques, welding/repairing molds and final assembly of cavity and core components. Students will also be required to design and build a proto-type injection mold.

PREREQUISITES: **Mold Making I and Mold Making II**

REQUIRED COURSE MATERIALS:

Textbook: Injection Molds and Molding, by Joseph B. Dym
Moldmaking and Die Cast Dies for Metalworking Trainees, by John Kluz, National Tooling and Machining Association, publishers

Lab Manual: **NONE**

Hand Tools/Quantity Required: Basic Tool List (See Machine Tool Practices I)

METHODS OF INSTRUCTION:

Lecture: Didactic presentations will include lectures, discussions, visual aids, and demonstrations.

Laboratory: Laboratory will consist of "hands on" activities which will enable the student to learn the necessary basic skills to make design and build plastic injection molds.

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.
Heat Treatment Equipment		2
Quenching Mediums		2
Hardening, Tempering & Annealing		2
Hardness Testing		2
Methods of Producing Cores and Cavities		2
Preparation of a Mold Base		4
Grinding and Fitting Core and Cavity		2
Transfer Ejection Holes, Screws and Make Ejection System		4
Advanced Mold Design		4
Welding on Molds		2
Working Sketch		4
Select Plastic Materials & Calculate Shrinkage		2
Calculate Mold Dimensions and Tolerances		2
Mold Manufacture and Component Selection		2
	Total Lecture Hours	**36**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Manufacture cavity and core blanks	12
Harden and temper core and cavity blanks	12
Grind, finish and fit core and cavity	12
Hone core ejection holes and fit ejector pins	8
Correctly measure core and cavity	3
Transfer ejection holes, screw holes and make ejection system	3
Design and build a proto-type injection mold	12
Determine if parts should be standard or manufactured, ensuring that each part is made or purchased in the most economical manner	4
Make a working sketch of core and cavity to be used in conjunction with a master mold frame	6
Select proper plastic material, calculate shrinkage, calculate mold tolerances, select mold steels, select correct gates, runners and vents	12
Build core and cavity to fit master frame	12
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. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Interpret safety manual directives
   d. Comply with established company safety practices
2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when handling molds or other heavy materials (e.g., eye bolts, slings, cables)
3. Debur Mold Bases to Help Avoid Cuts
   a. Chamfer outside edges of mold bases
   b. Do not debur parting edges of mold cavities, runners, gates, etc.
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Keep machine and hand tools clean at all times
   c. Put tools away when not in use
   d. Keep aisles clear of equipment and materials

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
2. Locate Machining Points from a Datum Point
   a. Identify points using the Cartesian coordinate system
   b. Identify points using the polar coordinate system
   c. Identify points using the absolute dimensioning system
   d. Identify points using the incremental dimensioning system
   e. Identify reasons for establishing datum point in the center of the mold base
3. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
4. Interconvert Metric/English measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
5. Perform Basic Trigonometric Functions
   a. Solve for unknown angles
   b. Solve for unknown sides
   c. Calculate for bolt circles
6. Use Sine Bar or Sine Plate for Machine Operations

a. Use trigonometric tables for solutions
b. Use calculator for solutions
c. Calculate gage block build up

7. Calculate Draft Angles
   a. Discuss reason for draft in the mold
   b. Discuss recommended draft angles for various molding processes
   c. Use D-M-E table to determine draft angles for parts of different thickness
8. Calculate Runner Size for Molding
   a. Calculate optimum runner diameter
   b. Calculate optimum runner length
9. Apply "Shrink Rate" Formulas
   a. Discuss shrink figures for various thermoplastic materials
   b. Discuss causes for shrink rate variations
   c. Apply shrink rate formulas to mold design
10. Calculate for Direct, Simple, and Angular Indexing
    a. Calculate for direct indexing
    b. Calculate for simple indexing (plain)
    c. Calculate for angular indexing
    d. Use Machinery's Handbook for calculations
11. Calculate Speeds and Feeds for Machining
    a. Calculate RPM for various metals and various tools
    b. Calculate feed for various metals, tools, and depths of cut

C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify item number symbols
   c. Identify general note symbols
   d. List the essential components found in the title block
   e. Locate bill of materials in a drawing
   f. List the components found in the revision block
3. Identify Basic Types of Drawings
   a. Identify orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)
   c. Visualize one or more views from a given view
   d. Identify isometric views
   e. Identify exploded isometric drawings
   f. Identify assembly drawings

4. List the Purpose of Each Type of Drawing
   a. Discuss purpose of orthographic (3 views) drawings
   b. Discuss purpose of isometric drawing
   c. Discuss purpose of exploded isometric drawing
   d. Discuss purpose of assembly drawings
5. Verify Drawing Elements
   a. Determine the scale of the view or section
   b. Check for revisions
   c. Recognize out-of-date blueprints
6. Identify Lines and Symbols (GD&T)
   a. Discuss the reason for GD&T
   b. Identify symbols for controlling location (or true position) of part features
   c. Identify symbols for controlling form (or alignment) of part features
   d. Identify symbols for showing datums and basic dimensions on drawings
   e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)
7. Describe the Relationship of Engineering Drawings to Planning
   a. Discuss production schedule
   b. Discuss Material Resource Planning (MRP)
   c. Discuss inventory control records
   d. Discuss shop floor routing documents
8. Use Standards to Verify Requirements
   a. Discuss the purpose of standards
   b. Discuss source locations for standards
9. Analyze Bill of Materials (BOM)
   a. Discuss components found on BOM
   b. Discuss components found in parts lists
10. Create Technical Sketches
   a. Discuss the value of sketching as a communication tool
   b. Describe basic orthographic sketching techniques
   c. Describe basic isometric sketching techniques
   d. Draw a sketch of a machine part

D. SELECT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
   a. Discuss classification system for metals
   b. Discuss general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals
2. Identify Heat Treating Processes
   a. Discuss the reasons for heat treating
   b. Discuss the time/temperature chart
   c. List the different quenching mediums
   d. Estimate metal heat temperature by color
   e. Discuss purpose of normalizing
   f. Discuss purpose of annealing
   g. Discuss purpose of stress relieving
   h. Discuss purpose of hardening
   i. Discuss purpose of tempering

j. Discuss purpose of nitriding

3. Perform Heat Treating Operations
   a. Normalize plain carbon workpiece
   b. Anneal plain carbon workpiece
   c. Stress Relieve plain carbon workpiece
   d. Harden workpiece
   e. Temper workpiece
4. Test Metal Samples for Hardness
   a. Perform spark test to test for metal hardness
   b. Perform Rockwell hardness tests
   c. Perform Brinell hardness tests
   d. Prepare metal samples for viewing under a microscope
5. Identify Types of Plastic Materials
   a. Discuss advantages of using plastics
   b. Discuss classifications of plastics
   c. Discuss forms available forms (e.g., resins, coatings, adhesives, laminates, compounds)
   d. Discuss properties
6. Identify Plastic Molding Processes
   a. Describe the blow molding process
   b. Describe the vacuum forming process
   c. Describe the injection molding process
   d. Describe the reaction injection molding process
   e. Describe the extrusion molding process
   f. Describe the compression molding process
   g. Describe the transfer molding process
   h. Describe the rotational molding process
   i. Discuss the advantages of using composites
   j. Describe the composite molding methods
7. Identify Types of Mold Steels
   a. Discuss mold service requirements
   b. Discuss mold hardness requirements
   c. Discuss machinability of mold steel
   d. Describe P-20, Plastic Mold Steel
   e. Describe A-2, Cold Work Tool Steel
   f. Describe S-1, Shock Resisting Tool Steel
   g. Describe H-13, Chromium type Hot Work Tool Steel
   h. Describe S-7, Shock Resisting Tool Steel
   i. Describe Type 414, Stainless Plastic Mold Steel
   j. Describe Type 420, Stainless Plastic Mold Steel
8. Use Pantograph for Mold Engraving
   a. Describe principle of the pantograph
   b. Discuss other methods of mold engraving (e.g., CNC, EDM)

E. PERFORM MEASUREMENT/INSPECTION

1. Identify Types of Measurement
   a. Distinguish between direct and calculated measurements
   b. Compute calculated measurements

c. Justify the use of precision measurements in manufacturing
d. Discuss the following: precision, reliability and accuracy
e. Demonstrate general measurement techniques
f. Demonstrate semi-precision measurement techniques
g. Demonstrate precision measurement techniques
h. Document results of measurement activities and calculations

2. Select Proper Measurement Tools
   a. Match appropriate measurement tools with various types of measurement requirements
   b. Demonstrate proper measurement tool usage
   c. List steps of proper measurement
   d. Explain rationale for each step
   e. Identify error possibilities in measurement tool selection
   f. Identify error possibilities within measurement procedures
   g. Identify common conversion error possibilities
   h. Discriminate between accepted measurement procedures and improper measurement procedures
3. Apply Proper Measuring Techniques
   a. Explain calibration requirements of various precision instruments
   b. Illustrate measurement differences when taken with calibrated and non-calibrated instruments
   c. Justify use of particular measurement tools based on tool characteristics
   d. Discuss factors affecting accurate measurement (dirt, temperature, etc.)
4. Measure With Hand Held Instruments
   a. Measure with steel rules (metric and inch)
   b. Measure with micrometers
   c. Measure with comparison measuring instruments (e.g., calipers, telescope gages, etc.)
   d. Measure with direct measuring instruments (e.g., vernier, dial, and digital instruments)
   e. Measure with fixed gages (go and not go gages)
5. Measure/Layout/Inspect Using Surface Plate
   a. Describe and properly use surface plate
   b. Use surface plate accessories correctly (sine bar, gage blocks, etc.)
   c. Check for part squareness
   d. Check part dimensions for accuracy
   e. Align workpieces using height gage and dial indicators
6. Inspect Using Stationary Equipment (e.g., CMM and optical comparator)
   a. Set up and use a Coordinate Measuring Machine (CMM)
   b. Set up and use an Optical Comparator

F. PERFORM CONVENTIONAL MACHINING OPERATIONS

1. Prepare and Plan For Machining Operations
   a. Read and interpret blueprints
   b. Perform basic semi-precision and precision layout as necessary
   c. Plan machining operations
   d. Understand machinability and chip formation
   e. Calculate speeds, feeds, and depth of cut for various machine applications

f. Use carbides and other tool materials to increase productivity
g. Use the Machinery's Handbook as a reference for machine applications

2. Use Proper Hand Tools
   a. Use arbor and shop presses
   b. Select necessary work-holding devices and hand tools as needed
   c. Select and use hand files
   d. Identify and use hand reamers
   e. Correctly identify and use hand taps as required
   f. Follow tapping procedures to produce internal threads
   g. Use thread-cutting dies to produce external threads
   h. Operate bench and pedestal grinders safely
3. Operate Power Saws
   a. Use reciprocating and horizontal band cutoff machines
   b. Operate abrasive and cold saws
   c. Prepare and use the vertical band saw
   d. Weld a bandsaw blade
4. Operate Drill Presses
   a. Describe the different types of drill presses found in the machine shop
   b. Describe and use standard drilling tools
   c. Sharpen a drill bit using a bench or pedestal grinder
   d. Setup the drill presses for drilling, countersinking, counterboring, reaming, and tapping operations
   e. Drill holes using drill jigs
5. Operate Vertical Milling Machines
   a. Demonstrate the use of all controls on the vertical milling machine
   b. Align the vertical milling machine head
   c. Select, align and use workholding devices
   d. Select milling tool holders
   e. Select milling cutters
   f. Perform all standard vertical milling operations
   g. Bore a hole using the offset boring head
   h. Machine angles using sine bar and gage blocks
   i. Setup and use special vertical mill fixtures
   j. Setup and machine dovetails
   k. Machine keyways
6. Operate Horizontal Milling Machines
   a. Discuss the difference in plain and universal horizontal milling machines
   b. Discuss the types of spindles, arbors and adaptors used on the horizontal milling machine
   c. List several common work holding methods
   d. Use plain milling cutters
   e. Use side milling cutters
   f. Use face milling cutters
   g. Setup and use special horizontal mill fixtures
7. Operate Metal Cutting Lathes
   a. Demonstrate the use of all controls on the engine lathe
   b. Discuss standard tools and toolholders for the lathe

c. Face and center drill parts correctly
d. Drill, ream and bore on the lathe
e. Turn between centers
f. Discuss alignment of lathe centers
g. Make all calculations, lathe adjustments and settings to machine sixty-degree internal and external threads
h. Discuss thread fit classifications
i. Make all calculations, lathe adjustments and settings to machine Acme threads
j. Describe the common tapers used in the machine shop
k. Discuss taper cutting and calculations for the lathe
l. Setup and use the taper attachment found on most lathes
m. Use follower rests and steady rests
n. Use HSS cutting tools
o. Use carbide cutting tools
p. Setup and operate tracer lathes
q. Setup and operate turret lathes

8. Operate Grinding/Abrasive Machines
   a. Discuss the selection and identification of grinding wheels
   b. Inspect, mount, true, dress, and balance grinding wheels
   c. True table by indicator
   d. True back rail by indicator
   e. Make the form in the wheel
   f. Check the form in the wheel
   g. Discuss the selection of grinding fluids
   h. Operate horizontal spindle reciprocating table surface grinders
   i. Operate cylindrical grinders
   j. Operate ID and OD grinders
   k. Setup and operate tool and cutter grinders
   l. Discuss common problems and solutions in surface grinding
   m. Operate honing machine
   n. Operate lapping machines
9. Operate Jig Boring Machines
   a. Discuss jig bore accessories
   b. Operate conventional jig bore to locate and bore holes
   c. Demonstrate proper use of scopes
10. Operate Deburring Equipment
   a. Debur parts using pneumatic Deburring tools
   b. Debur parts using electric deburring tools
11. Polish Mold Cavities
   a. Discuss finish requirements of molds
   b. Discuss surface finish symbols
   c. Select abrasive for mold finishing
   d. Describe steps for achieving "mirror" finish
   e. Describe molding problems related to poor surface conditions

G. PERFORM ADVANCED MACHINING PROCESSES

1. Operate Electrical Discharge Machines

a. Discuss the EDM process
b. List advantages and disadvantages of the EDM process
c. Identify electrode materials
d. Machine EDM electrodes
e. Setup and operate die sinker EDM machines
f. Calculate overburn
g. Identify generator setting of machine
h. Choose proper techniques for flushing
i. Estimate number of roughers and finishers
j. Demonstrate proper electrode mounting techniques
k. Utilize 3R tooling
l. Perform touch-off procedures
m. Recognize optimum machine settings
n. Perform continuity checks
o. Determine R-MAX finish required
p. Setup and operate wire cut EDM machines

H. PERFORM WELDING OPERATIONS

1. Weld With Shielded Metal Arc Welding (SMAW) Process
   a. Discuss factors for welding electrode selection
   b. Adjust welding amperage setting for each application
   c. Demonstrate proper use of safety equipment
   d. Weld beads on plate (flat, horizontal, and vertical)
   e. Weld tee joints (flat, horizontal, and vertical)
   f. Weld pipe joints
   g. Discuss weld inspection factors and techniques
2. Weld/Cut With Oxyacetylene
   a. Setup and break down the oxyacetylene welding/cutting station
   b. Discuss proper settings for oxyacetylene regulators
   c. Discuss factors that determine torch welding and cutting tip selection
   d. Demonstrate routine torch maintenance procedures
   e. Weld beads on plate (with and without filler) in the flat and horizontal positions
   f. Weld square groove butt joints in the flat and horizontal positions
   g. Braze weld beads on plate in the flat position
   h. Make square cuts to a straight line with the cutting torch
   i. Demonstrate proper use of safety equipment
3. Weld With Gas Tungsten Arc Welding (GTAW) (Heliarc)
   a. Properly set up GTAW welder for welding steel
   b. Properly set up GTAW welder for welding aluminum
   c. Weld beads on plate (steel) with appropriate filler rod in the flat position
   d. Weld beads on plate (aluminum) with appropriate filler rod in the flat position
   e. Weld lap joints in the horizontal position on steel plate
   f. Weld lap joints in the horizontal position on aluminum plate
   g. Demonstrate proper use of safety equipment
4. Weld With Gas Metal Arc Welding (GMAW)/(MIG) and Flux Core Arc Welding (FCAW)

a. Set up machine for gas metal arc welding
b. Set up machine for flux cored arc welding
c. Weld beads on plate with gas metal arc welding system in the flat position
d. Weld beads on plate with flux cored welding system in the flat position
e. Weld lap joints on steel plate with the gas metal arc welding system in the horizontal position
f. Weld lap joints on steel plate with the flux cored arc welding system in the horizontal position

I. BUILD/REPAIR/MODIFY MOLDS

1. Identify Types of Molds (e.g., three plate, multi-cavity, cam action, hot runner)
   a. Identify/describe three plate mold
   b. Identify/describe multi-cavity molds
   c. Identify/describe runnerless molds
   d. Identify/describe cam action molds
2. Identify Typical Mold Components (e.g., cavity and core insert, ejector mechanisms, etc.)
   a. Identify/describe cavity inserts
   b. Identify/describe core inserts
   c. Describe engraving inserts
   d. Identify/describe ejector pins, blades and ejector plates
   e. Identify/describe stripper plates and rings
   f. Discuss and/or install compressed air ejector systems
3. Estimate Basic Mold Cost Considerations (e.g., engineering, material, labor)
   a. Discuss factors relating to molding process (high vs. low pressure)
   b. Discuss factors relating to molding material (hard vs. easy flow)
   c. Discuss factors relating to volume
   d. Discuss factors relating to part size
   e. Discuss factors relating to part complexity
   f. Discuss factors relating to part tolerances
4. Apply Basic Mold Design: Principles (nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs)
   a. Describe types of runner systems (e.g., full, half, quarter, trapezoidal, and modified trapezoidal)
   b. Describe laminar and turbulent flow
   c. Discuss the purpose of cold slug extensions
   d. Discuss recommended runner size for various materials
   e. Discuss common gate types (e.g., jump, tunnel, tab, ring, sprue, center, fan)
   f. Discuss mold venting (e.g., location, size, solutions)
   g. Discuss wall thickness
   h. Discuss part radius considerations
   i. Discuss rib design and placement
   j. Discuss draft angles
5. Install Mold Temperature Control Devices
   a. Describe mold baffles
   b. Describe mold bubblers
   c. Describe design of water line placements

d. Discuss mold cooling problems

6. Disassemble/Assemble Molds
   a. Completely disassemble a mold base
   b. Identify all components
   c. Assemble mold base to working condition
7. Identify "Off the Shelf" Mold Components
   a. Identify sources of molding components
   b. Use catalogues to order components for mold construction
8. Construct a Cavity and Core for an Injection Mold
   a. Machine a cavity for a mold
   b. Machine a core for a mold
   c. Install the components into the mold
   d. Check for proper mold operation
9. Build/Assemble/Adjust Ejector Plates and Pins
   a. Select proper type of ejector mechanism
   b. Determine size and placement of ejectors
   c. Locate, drill and assemble ejector plate w/ejector pins
   d. Assemble, measure, and final grind ejector lengths for proper clearance
   e. Check final operation of ejector mechanism
10. Vent Molds
   a. Determine mold vent requirements
   b. Determine mold size requirements
   c. Determine optimum mold locations
   d. Machine vent openings
   e. Hand finish vent to cavity openings
   f. Check final operation for "flash" and proper mold filling
11. Diagnose and Repair all Mold Related Problems
   a. Discuss possible solutions for mold thermal conductivity balancing
   b. Discuss possible solutions for highly stressed molding related problems
   c. Discuss possible solutions for defective surface conditions and voids
   d. Discuss possible solutions for long molding cycle times
   e. Discuss possible solutions for inability to fill thin sections or large areas
   f. Discuss possible solutions for ejection difficulties
   g. Discuss possible solutions for corrosion of cooling channels
   h. Discuss other problems such as thermal isolation and thermal expansion
12. Perform Preventative Maintenance (e.g., mold cleaners, mold releases, rust preventatives)
   a. Select/use mold cleaners
   b. Select/use mold releases
   c. Select/use rust preventatives
   d. Use "soft tools" around mold cavities

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. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of machining
3. provide a self-evaluation of performance based on the time and quality of work

B. Interpersonal: Works with others

1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. machine mold components to acceptable levels of quality as required
4. works well with all members of the class

C. Information: Acquires and uses information

1. read and interpret blueprints
2. organize and apply theories of mold design and construction

D. Systems: Understands complex inter-relationships

1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the mold design and construction
   d. systematic organization of training materials
2. monitors and corrects performance during
   a. the machining process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

E. Technology: Works with a variety of technologies

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a molded part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

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. studies student laboratory manual
b. interprets molding machine manuals
c. read/studies textbook
d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

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

a. maintain a lecture notebook
b. submit written responses to chapter question assignments
c. complete all written assignments

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

a. determines optimum mold design parameters for various plastic polymers
b. calculates "value added to the part"
c. adjusts machine parameters to achieve a quality part

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. assimilate classroom instruction
b. interpret and assimilate video instruction
c. observe laboratory demonstrations
d. seek and receive individualized instruction in the laboratory

5. ***Speaking:*** *Organizes ideas and communicates orally*

a. participates in classroom discussions
b. organize ideas and communicate specific questions to the instructor
c. verbally affirms understanding of a concept, procedure, or required skill
d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
b. identifies actions required to accomplish personal goals

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

a. makes daily accommodations to stay on schedule
b. seeks additional instruction/clarification for assignment completion
c. balances social and academic life/responsibilities

d. accepts responsibility

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the technician
   c. understands the relationship between different plastic materials and mold design variables and makes adjustments as necessary

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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement
   b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
   c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on machined parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. ***Integrity/Honesty:** Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Introduction to Mold Making, American Mold Builders Association, Editor: Eric L. Buckleitner

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

MAST

COURSE SYLLABUS

MOLD DESIGN AND MAINTENANCE

MAST PROGRAM
COURSE SYLLABUS
MOLD DESIGN AND MAINTENANCE

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

COURSE DESCRIPTION:

An introductory course on the basic design parameters of plastic injection molds, including mold flow, nominal walls projection, depressions, ejector systems, runners, gates, parting lines, and general mold configurations. Maintenance techniques are practiced on in house molds.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: Plastics: Materials and Processing, by Strong. Published by Prentice Hall. Latest edition.
Injection Molding Handbook, by Rosato. Published by Chapman & Hall. Second Edition.

Lab Manual: **NONE**

Hand Tools/Quantity Required: Eyeglasses

METHODS OF INSTRUCTION:

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

Laboratory: Laboratory will consist of "hands on" activities which will enable the student to take apart and reconstruct molds, use equipment for mold making to construct a cavity and core for an injection mold, and use of proper mold cleaners, mold releases and rust preventatives for mold maintenance.

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 Topic	Text Reference Page	Contact Hrs.
Tooling and Mold Making	(Chapter 22 IP)	2
Mold Flow Introduction		
Injection Mold Design	(Chapter 7 IMH)	6
A. Types of Molds		
1) Standard (2 plate)		
2) MUD		
3) 3 Plate		
4) Runnerless		
5) CAM		
B. Mold Components		
1) Cavity and Core Inserts		
2) Ejection Mechanism		
3) Mold Steels		
C. Heat Treatment		
D. Mold Cost Considerations		
EDM		1
Runners		3
Gates		3
Vents		3
Mold Temp Control		2
Part Design		4
A. Tolerances		
B. Wall Thickness		
C. Design for Flow		
D. Draft		
E. Taper		
F. Undercuts		
G. Designing for Holes		
H. Inserts		
I. Ribs		
J. Bosses		
K. Fillets		
L. Surface Quality		
	Total Lecture Hours	24

LAB OUTLINE:

Lab Topics	Contact Hrs.
Assembly/Disassembly of Molds	6
CAD/CAM	8
A. Designing a cavity and core	
Tooling a cavity and core	8
Assembly of cavity and core into mold base	8
Injection molding of new cavity and core	6
Total Lab Hours	**36**

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. Assume responsibility for the personal safety of oneself and others
   b. Develop a personal attitude towards safety
   c. Interpret safety manual directives
   d. Comply with established company safety practices
2. Use Protective Equipment
   a. Wear protective safety clothing as required
   b. Maintain and use protective guards and equipment on machinery
   c. Locate and properly use protective equipment
   d. Use lifting aids when handling molds or other heavy materials (e.g., eye bolts, slings, cables)
3. Debur Mold Bases to Help Avoid Cuts
   a. Chamfer outside edges of mold bases
   b. Do not debur parting edges of mold cavities, runners, gates, etc.
4. Maintain a Clean and Safe Work Environment
   a. Keep work areas clean
   b. Keep machine and hand tools clean at all times
   c. Put tools away when not in use
   d. Keep aisles clear of equipment and materials

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
2. Locate Machining Points from a Datum Point
   a. Identify points using the Cartesian coordinate system
   b. Identify points using the polar coordinate system
   c. Identify points using the absolute dimensioning system
   d. Identify points using the incremental dimensioning system
   e. Identify reasons for establishing datum point in the center of the mold base
3. Interconvert Fractions/Decimals
   a. Convert fractions to decimal equivalents
   b. Convert decimal values to nearest fractional equivalent
   c. Use Decimal Equivalent Chart for conversions
4. Interconvert Metric/English measurements
   a. Convert English dimensions to Metric
   b. Convert Metric dimensions to English
   c. Use Metric/English conversion chart
5. Perform Basic Trigonometric Functions
   a. Solve for unknown angles
   b. Solve for unknown sides
   c. Calculate for bolt circles
6. Use Sine Bar or Sine Plate for Machine Operations
   a. Use trigonometric tables for solutions

b. Use calculator for solutions
c. Calculate gage block build up

7. Calculate Draft Angles
   a. Discuss reason for draft in the mold
   b. Discuss recommended draft angles for various molding processes
   c. Use D-M-E table to determine draft angles for parts of different thickness
8. Calculate Runner Size for Molding
   a. Calculate optimum runner diameter
   b. Calculate optimum runner length
9. Apply "Shrink Rate" Formulas
   a. Discuss shrink figures for various thermoplastic materials
   b. Discuss causes for shrink rate variations
   c. Apply shrink rate formulas to mold design
10. Calculate Speeds and Feeds for Machining
   a. Calculate RPM for various metals and various tools
   b. Calculate feed for various metals, tools, and depths of cut

C. INTERPRET ENGINEERING DRAWINGS AND CONTROL DOCUMENTS

1. Review Blueprint Notes and Dimensions
   a. Explain basic blueprint terminology
   b. Identify the types of dimensions
   c. Identify general note symbols
   d. Locate notes on a print
   e. Interpret commonly used abbreviations and terminology
   f. Determine tolerances associated with dimensions on a drawing
   g. Determine the tolerance for a reference dimension
   h. Determine the surface finish for a given part
   i. List the essential components found in the general drawing notes
2. Identify Basic Layout of Drawings
   a. Identify types of lines within a drawing
   b. Identify item number symbols
   c. Identify general note symbols
   d. List the essential components found in the title block
   e. Locate bill of materials in a drawing
   f. List the components found in the revision block
3. Identify Basic Types of Drawings
   a. Identify orthographic views
   b. Identify positions of views (top, front, side, and auxiliary)
   c. Visualize one or more views from a given view
   d. Identify isometric views
   e. Identify exploded isometric drawings
   f. Identify assembly drawings
4. List the Purpose of Each Type of Drawing
   a. Discuss purpose of orthographic (3 views) drawings
   b. Discuss purpose of isometric drawing
   c. Discuss purpose of exploded isometric drawing
   d. Discuss purpose of assembly drawings
5. Verify Drawing Elements
   a. Determine the scale of the view or section

b. Check for revisions
c. Recognize out-of-date blueprints

6. Identify Lines and Symbols (GD&T)
   a. Discuss the reason for GD&T
   b. Identify symbols for controlling location (or true position) of part features
   c. Identify symbols for controlling form (or alignment) of part features
   d. Identify symbols for showing datums and basic dimensions on drawings
   e. Identify symbols for Maximum Material Size (MMS) and Regardless of Feature Size (RFS)
7. Describe the Relationship of Engineering Drawings to Planning
   a. Discuss production schedule
   b. Discuss Material Resource Planning (MRP)
   c. Discuss inventory control records
   d. Discuss shop floor routing documents
8. Use Standards to Verify Requirements
   a. Discuss the purpose of standards
   b. Discuss source locations for standards
9. Analyze Bill of Materials (BOM)
   a. Discuss components found on BOM
   b. Discuss components found in parts lists
10. Create Technical Sketches
   a. Discuss the value of sketching as a communication tool
   b. Describe basic orthographic sketching techniques
   c. Describe basic isometric sketching techniques
   d. Draw a sketch of a machine part

D. SELECT MANUFACTURING MATERIALS AND PROCESSES

1. Identify Materials With Desired Properties
   a. Discuss classification system for metals
   b. Discuss general characteristics for carbon steels, tool steels, stainless steels, structural steels, cast irons, aluminum, and other commonly used metals
2. Identify Heat Treating Processes
   a. Discuss the reasons for heat treating
   b. Discuss the time/temperature chart
   c. List the different quenching mediums
   d. Estimate metal heat temperature by color
   e. Discuss purpose of normalizing
   f. Discuss purpose of annealing
   g. Discuss purpose of stress relieving
   h. Discuss purpose of hardening
   i. Discuss purpose of tempering
   j. Discuss purpose of nitriding
3. Test Metal Samples for Hardness
   a. Perform spark test to test for metal hardness
   b. Perform Rockwell hardness tests
   c. Perform Brinell hardness tests
   d. Prepare metal samples for viewing under a microscope
4. Identify Types of Plastic Materials
   a. Discuss advantages of using plastics

b. Discuss classifications of plastics
c. Discuss forms available forms (e.g., resins, coatings, adhesives, laminates, compounds)
d. Discuss properties

5. Identify Plastic Molding Processes
   a. Describe the injection molding process
6. Identify Types of Mold Steels
   a. Discuss mold service requirements
   b. Discuss mold hardness requirements
   c. Discuss machinability of mold steel
   d. Describe P-20, Plastic Mold Steel
   e. Describe A-2, Cold Work Tool Steel
   f. Describe S-1, Shock Resisting Tool Steel
   g. Describe H-13, Chromium type Hot Work Tool Steel
   h. Describe S-7, Shock Resisting Tool Steel
   i. Describe Type 414, Stainless Plastic Mold Steel
   j. Describe Type 420, Stainless Plastic Mold Steel

E. PERFORM MEASUREMENT/INSPECTION

1. Identify Types of Measurement
   a. Distinguish between direct and calculated measurements
   b. Compute calculated measurements
   c. Justify the use of precision measurements in manufacturing
   d. Discuss the following: precision, reliability and accuracy
   e. Demonstrate general measurement techniques
   f. Demonstrate semi-precision measurement techniques
   g. Demonstrate precision measurement techniques
   h. Document results of measurement activities and calculations
2. Select Proper Measurement Tools
   a. Match appropriate measurement tools with various types of measurement requirements
   b. Demonstrate proper measurement tool usage
   c. List steps of proper measurement
   d. Explain rationale for each step
   e. Identify error possibilities in measurement tool selection
   f. Identify error possibilities within measurement procedures
   g. Identify common conversion error possibilities
   h. Discriminate between accepted measurement procedures and improper measurement procedures
3. Apply Proper Measuring Techniques
   a. Explain calibration requirements of various precision instruments
   b. Illustrate measurement differences when taken with calibrated and non-calibrated instruments
   c. Justify use of particular measurement tools based on tool characteristics
   d. Discuss factors affecting accurate measurement (dirt, temperature, etc.)
4. Measure With Hand Held Instruments
   a. Measure with steel rules (metric and inch)
   b. Measure with micrometers

c. Measure with comparison measuring instruments (e.g., calipers, telescope gages, etc.)
d. Measure with direct measuring instruments (e.g., vernier, dial, and digital instruments)
e. Measure with fixed gages (go and not go gages)

5. Measure/Layout/Inspect Using Surface Plate
   a. Describe and properly use surface plate
   b. Use surface plate accessories correctly (sine bar, gage blocks, etc.)
   c. Check for part squareness
   d. Check part dimensions for accuracy
   e. Align workpieces using height gage and dial indicators

F. PERFORM CONVENTIONAL MACHINING OPERATIONS

1. Prepare and Plan For Machining Operations
   a. Read and interpret blueprints
   b. Perform basic semi-precision and precision layout as necessary
   c. Plan machining operations
   d. Understand machinability and chip formation
   e. Calculate speeds, feeds, and depth of cut for various machine applications
   f. Use carbides and other tool materials to increase productivity
   g. Use the Machinery's Handbook as a reference for machine applications
2. Use Proper Hand Tools
   a. Use arbor and shop presses
   b. Select necessary work-holding devices and hand tools as needed
   c. Select and use hand files
   d. Identify and use hand reamers
   e. Correctly identify and use hand taps as required
   f. Follow tapping procedures to produce internal threads
   g. Use thread-cutting dies to produce external threads
   h. Operate bench and pedestal grinders safely
3. Operate Power Saws
   a. Use reciprocating and horizontal band cutoff machines
   b. Operate abrasive and cold saws
   c. Prepare and use the vertical band saw
   d. Weld a bandsaw blade
4. Operate Drill Presses
   a. Describe the different types of drill presses found in the machine shop
   b. Describe and use standard drilling tools
   c. Sharpen a drill bit using a bench or pedestal grinder
   d. Setup the drill presses for drilling, countersinking, counterboring, reaming, and tapping operations
   e. Drill holes using drill jigs
5. Operate Vertical Milling Machines
   a. Demonstrate the use of all controls on the vertical milling machine
   b. Align the vertical milling machine head
   c. Select, align and use workholding devices
   d. Select milling tool holders
   e. Select milling cutters
   f. Perform all standard vertical milling operations

g. Bore a hole using the offset boring head
h. Machine angles using sine bar and gage blocks
i. Setup and use special vertical mill fixtures
j. Setup and machine dovetails
k. Machine keyways

6. Operate Horizontal Milling Machines
   a. Discuss the difference in plain and universal horizontal milling machines
   b. Discuss the types of spindles, arbors and adaptors used on the horizontal milling machine
   c. List several common work holding methods
   d. Use plain milling cutters
   e. Use side milling cutters
   f. Use face milling cutters
   g. Setup and use special horizontal mill fixtures
7. Operate Metal Cutting Lathes
   a. Demonstrate the use of all controls on the engine lathe
   b. Discuss standard tools and toolholders for the lathe
   c. Face and center drill parts correctly
   d. Drill, ream and bore on the lathe
   e. Turn between centers
   f. Discuss alignment of lathe centers
   g. Make all calculations, lathe adjustments and settings to machine sixty-degree internal and external threads
   h. Discuss thread fit classifications
   i. Make all calculations, lathe adjustments and settings to machine Acme threads
   j. Describe the common tapers used in the machine shop
   k. Discuss taper cutting and calculations for the lathe
   l. Setup and use the taper attachment found on most lathes
   m. Use follower rests and steady rests
   n. Use HSS cutting tools
   o. Use carbide cutting tools
8. Operate Grinding/Abrasive Machines
   a. Discuss the selection and identification of grinding wheels
   b. Inspect, mount, true, dress, and balance grinding wheels
   c. True table by indicator
   d. True back rail by indicator
   e. Make the form in the wheel
   f. Check the form in the wheel
   g. Discuss the selection of grinding fluids
   h. Operate horizontal spindle reciprocating table surface grinders
   i. Discuss common problems and solutions in surface grinding
9. Operate Deburring Equipment
   a. Debur parts using pneumatic Deburring tools
   b. Debur parts using electric deburring tools
10. Polish Mold Cavities
   a. Discuss finish requirements of molds
   b. Discuss surface finish symbols

c. Select abrasive for mold finishing
d. Describe steps for achieving "mirror" finish
e. Describe molding problems related to poor surface conditions

G. PERFORM ADVANCED MACHINING PROCESSES

1. Program CNC machine with a CAM system
   a. Install CAM software on a personal computer
   b. Plan machine operations
   c. Select tools/speeds/feeds for optimum cutting
   d. Create manufacturing models using a CAM system
   e. Review part geometry to verify tool path
   f. Edit models using a CAM system
   g. Generate CNC code using a CAM system
   h. Write post processors for a CAM system
   i. Transfer CAM files to a CAD system

H. BUILD/REPAIR/MODIFY MOLDS

1. Identify Types of Molds (e.g., three plate, multi-cavity, cam action, hot runner)
   a. Identify/describe three plate mold
   b. Identify/describe multi-cavity molds
   c. Identify/describe runnerless molds
   d. Identify/describe cam action molds
2. Identify Typical Mold Components (e.g., cavity and core insert, ejector mechanisms, etc.)
   a. Identify/describe cavity inserts
   b. Identify/describe core inserts
   c. Describe engraving inserts
   d. Identify/describe ejector pins, blades and ejector plates
   e. Identify/describe stripper plates and rings
   f. Discuss and/or install compressed air ejector systems
3. Estimate Basic Mold Cost Considerations (e.g., engineering, material, labor)
   a. Discuss factors relating to molding process (high vs. low pressure)
   b. Discuss factors relating to molding material (hard vs. easy flow)
   c. Discuss factors relating to volume
   d. Discuss factors relating to part size
   e. Discuss factors relating to part complexity
   f. Discuss factors relating to part tolerances
4. Apply Basic Mold Design: Principles (e.g., nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs, etc.)
   a. Describe types of runner systems (e.g., full, half, quarter, trapezoidal, and modified trapezoidal)
   b. Describe laminar and turbulent flow
   c. Discuss the purpose of cold slug extensions
   d. Discuss recommended runner size for various materials
   e. Discuss common gate types (e.g., jump, tunnel, tab, ring, sprue, center, fan)
   f. Discuss mold venting (e.g., location, size, solutions)
   g. Discuss wall thickness
   h. Discuss part radius considerations
   i. Discuss rib design and placement

j. Discuss draft angles

5. Install Mold Temperature Control Devices
   a. Describe mold baffles
   b. Describe mold bubblers
   c. Describe design of water line placements
   d. Discuss mold cooling problems
6. Disassemble/Assemble Molds
   a. Completely disassemble a mold base
   b. Identify all components
   c. Assemble mold base to working condition
7. Identify "Off the Shelf" Mold Components
   a. Identify sources of molding components
   b. Use catalogues to order components for mold construction
8. Construct a Cavity and Core for an Injection Mold
   a. Machine a cavity for a mold
   b. Machine a core for a mold
   c. Install the components into the mold
   d. Check for proper mold operation
9. Build/Assemble/Adjust Ejector Plates and Pins
   a. Select proper type of ejector mechanism
   b. Determine size and placement of ejectors
   c. Locate, drill and assemble ejector plate w/ejector pins
   d. Assemble, measure, and final grind ejector lengths for proper clearance
   e. Check final operation of ejector mechanism
10. Vent Molds
   a. Determine mold vent requirements
   b. Determine mold size requirements
   c. Determine optimum mold locations
   d. Machine vent openings
   e. Hand finish vent to cavity openings
   f. Check final operation for "flash" and proper mold filling
11. Diagnose and Repair all Mold Related Problems
   a. Discuss possible solutions for mold thermal conductivity balancing
   b. Discuss possible solutions for highly stressed molding related problems
   c. Discuss possible solutions for defective surface conditions and voids
   d. Discuss possible solutions for long molding cycle times
   e. Discuss possible solutions for inability to fill thin sections or large areas
   f. Discuss possible solutions for ejection difficulties
   g. Discuss possible solutions for corrosion of cooling channels
   h. Discuss other problems such as thermal isolation and thermal expansion
12. Perform Preventative Maintenance (e.g., mold cleaners, mold releases, rust preventatives)
   a. Select/use mold cleaners
   b. Select/use mold releases
   c. Select/use rust preventatives
   d. Use "soft tools" around mold cavities

I. USE COMPUTERS

1. Use Computer Operating Systems

a. Use basic computer terminology appropriately and accurately
b. Boot the computer and recognize the basic components of DOS
c. Use DOS to perform file management
d. Use DOS to perform directory management

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. follows a schedule to complete assigned tasks on time
2. determine the initial cost of materials and "value added" as result of processing
3. provide a self-evaluation of performance based on the time and quality of work

B. Interpersonal: Works with others
1. complete assigned responsibilities within the shop floor serving as a member of the team
2. provide individual assistance/direction to peers as requested
3. produce molded parts to acceptable levels of quality as required
4. works well with all members of the class

C. Information: Acquires and uses information
1. read and interpret blueprints
2. organize and apply theories of plastic molding equipment operation

D. Systems: Understands complex inter-relationships
1. demonstrate knowledge of the following systems:
   a. laboratory organization structure: physical and social
   b. organization of personnel and facilities on the shop floor
   c. systematic approach to the plastic molding process
   d. systematic organization of training materials
2. monitors and corrects performance during
   a. the molding process
   b. adjustments of individual laboratory work schedule
   c. constantly evaluating the quality of work to achieve acceptable standards
   d. maintains record of evaluations and sets individual goals

E. Technology: Works with a variety of technologies

1. chooses procedure, tools and equipment required to produce a part
2. applies appropriate procedures and uses appropriate tools and equipment to produce a molded part to acceptable standards
3. maintains and troubleshoots equipment
   a. applies appropriate preventative maintenance
   b. when operating machines
   c. reports all malfunctions of equipment to supervisor/instructor
   d. perform clean-up assignments of machine and shop floor at the end of the laboratory

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. studies student laboratory manual
   b. interprets molding machine manuals
   c. read/studies textbook
   d. follow a daily laboratory schedule to maintain appropriate time-line and product completion

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. outline the steps necessary to produce a molded plastic part
   b. maintain a lecture notebook
   c. submit written responses to chapter question assignments
   d. complete all written assignments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. determines optimum time and temperature settings for various plastic polymers
   b. calculates "value added to the part"
   c. adjusts timers and heaters to maintain a quality part

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. assimilate classroom instruction
   b. interpret and assimilate video instruction
   c. observe laboratory demonstrations
   d. seek and receive individualized instruction in the laboratory

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. participates in classroom discussions
   b. organize ideas and communicate specific questions to the instructor
   c. verbally affirms understanding of a concept, procedure, or required skill
   d. communicates with peers to ensure the smooth and safe operation of the laboratory

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. identifies personal goals
   b. identifies actions required to accomplish personal goals
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. makes daily accommodations to stay on schedule
   b. seeks additional instruction/clarification for assignment completion
   c. balances social and academic life/responsibilities
   d. accepts responsibility
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. interprets technical drawings
   b. interprets technical illustrations and symbols
   c. understands both written and verbal instructions
   d. assimilates process during instructor demonstrations
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. demonstrate mastery of the basic skills and techniques
   b. use these sequential skills to support mastery of new skills
   c. understand the sequential nature of acquired skills and the subsequent knowledge application of new skills and techniques
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. understands that practice may not make it perfect but it certainly will improve the skill of the operator
   b. understands that the quality of the product is a function of the time of the operation and the attitude and skill of the technician
   c. understands the relationship between different plastic materials and the processing variables and adjusts molding parameters 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. develops an understanding that in order to be successful you must be a "good" student
   b. develops an understanding that a "good" student is the one who is prompt to every class and has prepared for the day's work
   c. develops an understanding good students know what they are going to do in class and does not waste time
   d. develops a fine work-ethic
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. learns to take pride in his or her work through positive reinforcement

b. sees himself or herself as an asset to the class through continued contributions to the group and a shared common goal
c. understands that an individual with a positive attitude and the belief in their own abilities will systematically seek solutions and be a valuable employee

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. assist classmates in improving technical skills
   b. assist students with special needs as a peer mentor
   c. share laboratory resources (machines, tools and instructor's individual attention)
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. perform in-process quality checks on molded parts
   b. maintain a record of academic achievement (individual grade book)
   c. make accommodations to laboratory schedules due to broken machines/tools
   d. accept the responsibility for self-management
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. accept the responsibility for own actions
   b. exhibit personal honesty at all times
   c. accept the challenge of doing your own work in the laboratory, during examination, and on outside assignments
   d. understand the consequences of unethical behaviors

Appropriate Reference Materials:

1. Mold-Making Handbook for the Plastics Engineer, edited by Klaus Stoeckhert
2. Injection Mold Design, by R.G.W. Pye

MET330
01/072496

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

MAST

COURSE SYLLABUS

ENGINEERING TECHNOLOGY PROJECT

MAST PROGRAM
COURSE SYLLABUS
ENGINEERING TECHNOLOGY PROJECT

Lecture hours/week: 4 **Lab hours/week: 6** **Credit hours: 6**

COURSE DESCRIPTION:

Different industrial level projects emphasizing manufacturing applications/research in the areas of *CNC*, CAD/CAM, CIM, or Plastic *Mold Making* will be assigned to students utilizing a team concept.

PREREQUISITES: **NONE**

REQUIRED COURSE MATERIALS:

Textbook: **NONE**
Lab Manual: **NONE**

Hand Tools/Quantity Required: See basic tool list for Machine Tool Practices I

METHODS OF INSTRUCTION:

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

Laboratory: Laboratory will be a "hands-on" manufacturing assignments which will require the use of problem solving skills by the students.

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 content will be determined by the instructor based on the manufacturing-related exercise(s) which have been selected for the students.

Total Lecture Hours 48

LAB OUTLINE:

Lab activities will be determined by the instructor based on the manufacturing-related exercise(s) which have been selected for the students.

Total Lab Hours 72

COURSE OBJECTIVES: TECHNICAL COMPETENCIES

Technical competencies will be determined for each individual class. The instructor will select certain manufacturing-related problem solving/troubleshooting exercises which will simulate problems in "the real world." Students will work in teams to solve these problems. This may require machine maintenance, tool/fixture building, or any other activities which will lead to the successful completion of the required assignment. Technical competencies will be covered which will reinforce or strengthen the training/education the students have received in prior courses.

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.

***** **THIS COURSE CAN BE CONSIDERED TO BE SCANS INTENSIVE DUE TO THE NATURE AND STRUCTURE OF THE COURSE.**

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*
Students will draw from information learned in their other classes to identify problems, organize and plan work, and allocate resources necessary to solve assigned manufacturing-related problems.

B. *Interpersonal: Works with others*
Emphasis will be on working in teams to identify, solve and document solutions to assigned manufacturing-related problems.

C. *Information: Acquires and uses information*
Students will draw from information learned in their other classes to identify problems, organize and plan work, and allocate resources necessary to solve assigned manufacturing-related problems.

D. *Systems: Understands complex inter-relationships*
Students will draw from information learned in their other classes to identify problems, organize and plan work, and allocate resources necessary to solve assigned manufacturing-related problems.

E. *Technology: Works with a variety of technologies*
Students will draw from information learned in their other classes to identify problems, organize and plan work, and allocate resources necessary to solve assigned manufacturing-related problems. Students will be teamed up with students from other disciplines and expected to communicate and work with a variety of technologies to complete the course assignments.

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*
Students will be expected to use research techniques to find solutions to assigned work. This may include using machinery manuals and charts to troubleshoot equipment.

2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
Students will be expected to document the steps required to complete the assigned work. Students will also be expected to write a final summary of the work performed in class.

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
Students may be expected to perform any computations necessary for the completion of their tasks.

4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
Students will have to communicate with the instructor and the other team members to successfully complete their tasks. Listening skills will be of paramount importance in this class.

5. *Speaking: Organizes ideas and communicates orally*
Students will be expected to communicate effectively with the instructor and the other team members to successfully complete their tasks. Each

student will be required to give a short (5-10 minute) final oral presentation of their findings/observations taken from the course.

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*
   Students will be required to determine goals and constraints, generate alternative solutions, consider risks/costs, and evaluate and choose the best alternative to satisfy the requirements of the course.
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   Students will be expected to recognize problems, devise, and implement a plan of action.
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   Students will be encouraged to organize, and process symbols, pictures, graphs, objects, and other information in order to solve specific manufacturing-related problems.
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   Student learning will be accomplished through problem solving techniques and team learning.
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   The format of this class is such that students will be working more with abstract concepts rather than absolute facts. This will help students to develop thinking and reasoning skills.

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*
   Successful completion of the course will come only after students have spent sufficient time and efforts in identifying problems, organizing and planning work, and allocating resources necessary to solve assigned manufacturing-related problems.
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   Students will be encouraged to use the information learned in their other classes to solve practical assignments. Successful completion of this course helps students achieve more of a positive view of their self.
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   Group problem solving activities will develop understanding, friendliness, adaptability, empathy, and politeness towards other team members.

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   Each team will be self managed. Team members will be expected to set goals, assess progress accurately, monitor their progress, and exhibit self-control.
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   Students will be expected to make reasonable contributions to team efforts and choose to do things the "right" way.

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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.

S 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
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

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

FUTURE TRENDS AND CONCERNS

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

Furnished By:

BYRON FLORENCE
Tool Room Manager

Texas State Technical College Waco

COMPETENCY PROFILE
Mold Maker

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

Texas State Technical College Waco

DJ Plastics

MOLD MAKER ... plan, layout, setup, and operate hand and machine tools to perform operations necessary for machining a new mold or repairing/modifying an existing mold to referenced design standards.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Debur mold bases to help avoid cuts	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 draft angles	B-8 Calculate runner size for molding	B-9 Apply "shrink rate" formulas	B-10 Calculate for direct, simple, and angular indexing	B-11 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 Identify the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 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	D-6 Identify types of plastic materials	D-7 Identify plastic molding processes	D-8 Identify types of mold steels	D-9 Use pantograph for mold engraving				
E Perform Measurement/ Inspection	E-1 Identify types of measurement	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 (e.g., CMM and optical comparator							
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 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	G-4 Program CNC machines with a CAM system									
H Perform Welding Operations	H-1 Weld with shielded metal arc welding (SMAW) process	H-2 Weld/cut with oxyacetylene	H-3 Weld with gas tungsten arc welding (GTAW) (Heliarc)	H-4 Weld with gas metal arc welding (GMAW)/(MIG) and flux core arc welding (FCAW)									
I Build/Repair/ Modify Molds	I-1 Identify types of molds (e.g., three plate, multi-cavity, cam action, hot runner)	I-2 Identify typical mold components (e.g., cavity and core insert, ejector mechanisms)	I-3 Estimate basic mold cost considerations (e.g., engineering, material, labor)	I-4 Apply basic mold design principles (e.g., nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs)	I-5 Install mold temperature control devices	I-6 Disassemble /assemble molds	I-7 Identify "off the shelf" mold components	I-8 Construct a cavity and core for an injection mold	I-9 Build/ assemble/ adjust ejector plates and pins	I-10 Vent molds	I-11 Diagnose and repair all mold related problems	I-12 Perform preventative maintenance (e.g., mold cleaners, mold releases, rust preventatives)	
J Use Computers	J-1 Use computer operating systems	J-2 Use computer inquiry systems	J-3 Use Computer Aided Drafting (CAD) software	J-4 Use various computer applications	J-5 Use mold flow software								

DT/MOLD PMS
MAST/01/100595

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
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

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

FUTURE TRENDS AND CONCERNS

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

Furnished By:

GERMAN UBINA
Mold Maker

BENJAMIN PERALTA
Mold Maker

ABEL SALAZAR
Mold Maker

DAVID ESCALANTE
Apprentice Mold Maker

MANUEL GARNICA
Apprentice Mold Maker

Texas State Technical College Waco

COMPETENCY PROFILE
Mold Maker

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

Texas State Technical College Waco

MOLD MAKER ... plan, layout, setup, and operate hand and machine tools to perform operations necessary for machining a new mold or repairing/modifying an existing mold to referenced design standards.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Debur mold bases to help avoid cuts	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 draft angles	B-8 Calculate runner size for molding	B-9 Apply "shrink rate" formulas	B-10 Calculate for direct, simple, and angular indexing	B-11 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 Identify the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 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	D-6 Identify types of plastic materials	D-7 Identify plastic molding processes	D-8 Identify types of mold steels	D-9 Use pantograph for mold engraving				
E Perform Measurement/ Inspection	E-1 Identify types of measurement	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 (e.g., CMM and optical comparator							
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 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	G-4 Program CNC machines with a CAM system									
H Perform Welding Operations	H-1 Weld with shielded metal arc welding (SMAW) process	H-2 Weld/cut with oxyacetylene	H-3 Weld with gas tungsten arc welding (GTAW) (Heliarc)	H-4 Weld with gas metal arc welding (GMAW)/(MIG) and flux core arc welding (FCAW)									
I Build/Repair/ Modify Molds	I-1 Identify types of molds (e.g., three plate, multi-cavity, cam action, hot runner)	I-2 Identify typical mold components (e.g., cavity and core insert, ejector mechanisms)	I-3 Estimate basic mold cost considerations (e.g., engineering, material, labor)	I-4 Apply basic mold design principles (e.g., nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs)	I-5 Install mold temperature control devices	I-6 Disassemble /assemble molds	I-7 Identify "off the shelf" mold components	I-8 Construct a cavity and core for an injection mold	I-9 Build/ assemble/adjust ejector plates and pins	I-10 Vent molds	I-11 Diagnose and repair all mold related problems	I-12 Perform preventative maintenance (e.g., mold cleaners, mold releases, rust preventatives)	
J Use Computers	J-1 Use computer operating systems	J-2 Use computer inquiry systems	J-3 Use Computer Aided Drafting (CAD) software	J-4 Use various computer applications	J-5 Use mold flow software								

EUREMOLD PMS
MAST 052695

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
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

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

FUTURE TRENDS AND CONCERNS

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Director

DR. JON BOTSFORD
Assistant Director

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

OMER VANOVERSTRAETEN
Vice President, Molds and Tooling

Texas State Technical College Waco

COMPETENCY PROFILE
Mold Maker

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

Texas State Technical College Waco

FMI
FOSTER MOLD, INC.

MOLD MAKER ... plan, layout, setup, and operate hand and machine tools to perform operations necessary for machining a new mold or repairing/modifying an existing mold to referenced design standards.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Debur mold bases to help avoid cuts	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 draft angles	B-8 Calculate runner size for molding	B-9 Apply "shrink rate" formulas	B-10 Calculate for direct, simple, and angular indexing	B-11 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 Identify the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 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	D-6 Identify types of plastic materials	D-7 Identify plastic molding processes	D-8 Identify types of mold steels	D-9 Use pantograph for mold engraving				
E Perform Measurement/ Inspection	E-1 Identify types of measurement	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 (e.g., CMM and optical comparator							
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 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	G-4 Program CNC machines with a CAM system									
H Perform Welding Operations	H-1 Weld with shielded metal arc welding (SMAW) process	H-2 Weld/cut with oxyacetylene	H-3 Weld with gas tungsten arc welding (GTAW) (Heliarc)	H-4 Weld with gas metal arc welding (GMAW)/(MIG) and flux core arc welding (FCAW)									
I Build/Repair/ Modify Molds	I-1 Identify types of molds (e.g., three plate, multi-cavity, cam action, hot runner)	I-2 Identify typical mold components (e.g., cavity and core insert, ejector mechanisms)	I-3 Estimate basic mold cost considerations (e.g., engineering, material, labor)	I-4 Apply basic mold design principles (e.g., nominal walls, projections, depressions, ejector systems, runners, gates, parting lines, draft, radii, ribs)	I-5 Install mold temperature control devices	I-6 Disassemble /assemble molds	I-7 Identify "off the shelf" mold components	I-8 Construct a cavity and core for an injection mold	I-9 Build/ assemble/ adjust ejector plates and pins	I-10 Vent molds	I-11 Diagnose and repair all mold related problems	I-12 Perform preventative maintenance (e.g., mold cleaners, mold releases, rust preventatives)	
J Use Computers	J-1 Use computer operating systems	J-2 Use computer inquiry systems	J-3 Use Computer Aided Drafting (CAD) software	J-4 Use various computer applications	J-5 Use mold flow software								

FMMOLD PMS
MAST/01/100995

SKILLS AND KNOWLEDGE

Direct vs. Indirect Cost Understanding
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
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-Conscientiousness in Performance of the Job

TRAITS AND ATTITUDES

Cost Conscientiousness
Empowerment of Employees
Strong Work Ethic
Interpersonal Skills
Punctuality
Dependability
Honesty
Neatness
Safety Conscientious
Motivation
Responsible
Physical Ability
Professional
Trustworthy
Customer Relations
Personal Ethics

TOOLS AND EQUIPMENT

FUTURE TRENDS AND CONCERNS

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Assistant Director

JOE PENICK
Project Coordinator

TERRY SAWMA
Research Coordinator

WALLACE PELTON
Site Coordinator

ROSE MARY TIMMONS
Senior Secretary/Statistician

Furnished By:

RICKY FLAK
Vice President - Operations

NICK NICHOLS
Manufacturing Manager - Diamond Products

BRIAN SQUIRE
Mold Maker

GARY CHUNN
Mold Maker

Texas State Technical College Waco

COMPETENCY PROFILE

Mold Maker

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

Texas State Technical College Waco

SMITH GEODIAMOND

MOLD MAKER ... plan, layout, setup, and operate hand and machine tools to perform operations necessary for machining a new mold or repairing/modifying an existing mold to referenced design standards.

Duties	Tasks												
A Practice Safety	A-1 Follow safety manuals, and all safety regulations/ requirements	A-2 Use protective equipment	A-3 Debur mold bases to help avoid cuts	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 draft angles	B-8 Calculate runner size for molding	B-9 Cross-reference shrinkage factors for multiple fill materials	B-10 Calculate for direct, simple, and angular indexing	B-11 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 Identify the relationship of engineering drawings to planning	C-8 Use standards to verify requirements	C-9 Analyze bill of materials (BOM)	C-10 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	D-6 Identify types of mold steels	D-7 Use pantograph for mold engraving						
E Perform Measurement/ Inspection	E-1 Identify types of measurement	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 (e.g., CMM and optical comparator	E-7 Use ultrasonic to check for porosity and stress reliefs						
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 cavities		
G Build Molds For Multiple Fill Materials	G-1 Identify graphite properties	G-2 Apply permaplast clay	G-3 Install internal sand castings in mold cavity	G-4 Apply templates to contoured mold	G-5 Layout mold cavity	G-6 Broach mold and sculpture	G-7 Prepare for bonding process prior to brazing	G-8 Perform high temp brazing operations					
H Repair/Modify Molds	H-1 Identify types of molds (e.g., three plate, multi-cavity, cam action, hot runner)	H-2 Identify typical mold components (e.g., cavity and core insert, ejector mechanisms)	H-3 Estimate basic mold cost considerations (e.g., engineering, material, labor)	H-4 Apply basic mold design principles (e.g., nominal walls, projections, depressions, ejector systems)	H-5 Apply basic mold design principles (e.g., runners, gates, parting lines, draft, radii, ribs)	H-6 Install mold temperature control devices	H-7 Disassemble / assemble molds	H-8 Identify "off the shelf" mold components	H-9 Construct a cavity and core for an injection mold	H-10 Build/ assemble/ adjust ejector plates and pins	H-11 Vent molds	H-12 Diagnose and repair all mold related problems	H-13 Perform preventative maintenance (e.g., mold cleaners, mold releases, rust preventatives)
I Use Computers	I-1 Use computer operating systems	I-2 Use computer inquiry systems	I-3 Determine shrinkage rates with scientific calculator	I-4 Use various computer applications	I-5 Use mold flow software								

For more information:

MAST Program Director
Texas State Technical College
3801 Campus Drive
Waco, TX 76705

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U.S. DEPARTMENT OF EDUCATION
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