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**El Camino College
Industry Driven Regional Collaborative
For
Aerospace Manufacturing Engineering**

Manufacturing Processes

Course Outline; Manufacturing Processes

This class is designed to introduce shop floor personnel, CAD designers, estimators, planners, purchasing agents, and low-and-mid level managers to manufacturing processes. Its' intent is to give basic data so that the individual will recognize the differences, advantages, and limitations of various manufacturing processes.

This course will assist the student in preparation for certification as a Certified Manufacturing Technologist sponsored by the Society of Manufacturing Engineers.

Suggested Time; 24 hours (8 weeks @ 3 hours per week)
Suggested Credit; 1.5 semester units

In addition to the requirement of attending classes each student will be required to submit a 5-7 page paper on a manufacturing process of interest to the individual. The instructor must approve the subject matter. The student will be required to make a five minute presentation to the class on his chosen subject.

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Course Content:

1. Material Removal Processes I
2. Material Removal Processes II
3. Fabrication
4. Welding and Joining
5. Surface Preparation/Cleaning /Finishing/Painting
6. Casting/Molding/Forging/Extrusion of Metals
7. Extruding/Molding/Laminating/Forming of Plastics and Composites
8. Electronic Manufacturing Processes and Review



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Manufacturing Processes; Week 1

Metal Removal Processes I

Cutting Tools

- Tool Nomenclature
- Tool Angles
- Tool Failure and Tool Life
- Cutting Tool Materials
 - High Speed Steels
 - Cast Cobalt Alloys
 - Carbides
 - Coated Carbides
 - Ceramics
 - Cubic Boron Nitrides
 - Diamond
- Insert Nomenclature

Cutting Fluids

- Reasons for Use
 - Cooling
 - Lubrication
- Types
 - Oils
 - Emulsified Oils
 - Chemical and Semi-Chemical fluids
 - Gaseous
- Disposal
- Human Factors

Turning

- Machinery Nomenclature
 - Lathe Carriage
 - Headstock
 - Tailstock
 - Carriage
 - Tool Holders
- Work holding
 - 3-Jaw Chuck
 - 4-Jaw Chuck
 - Collets
 - Fixturing

Turning Machinery
Engine Lathe
Turret Lathe
CNC Lathes
 Standard
 Small/Gang Tooling
Screw Machines
 Automatic
 Single Spindle
 Multiple Spindle
Vertical Boring Mills
Tracer Lathes

Turning Calculations
Finishes/Tolerances

Drilling

Drilling Machinery
Vertical
Multiple Spindle
Radial
Turret
Micro-drilling
Gun-drilling
Trepanning

Twist Drills
Nomenclature
 Fractional
 Number and Letter
 Metric
Core Drills
Insert Drills
Counter-bores
Center Drills/Spot Drills
Spade Drills
Single Cutter Drills
 Gun-drills
 Trepanning

Drilling Calculations
Finishes/Tolerances

Milling

Machinery

- Vertical
- Horizontal
- Universal
- Horizontal Boring Mills
- Jig Boring

Cutting

- Peripheral
- Face
- Conventional
- Climb
- Positive
- Negative

Cutters

- End Mills
- Slab Mills
- Face Mills
- Special cutters

Milling Machine Tool Holders

- NMTB
- Boring Holders
- Special

Milling Calculations

Finishes/Tolerances

Manufacturing Processes; Week 2

Material Removal II

Sawing

- Machinery
 - Hack
 - Horizontal Bandsaw
 - Vertical Bandsaw
 - Circular/Carbide Tipped
 - Standard
 - Drop-Down Blade
 - Cut-Off
 - Plate
 - Friction
- Blade Nomenclature
 - Bandsaw
 - Pitch
 - Tooth Set
 - Circular
 - Carbide Tipped
 - Abrasive
- Finishes/Tolerances

Planing, Shaping, slotting

- Planers
 - Double Housing
 - Openside
 - Planer Mills
- Shapers
 - Horizontal
 - Vertical
- Finishes/Tolerances

Broaching

- Tools
- Broaching Machinery
 - Vertical
 - Horizontal

Grinding

- Machinery
 - Surface
 - Horizontal, Vertical
 - Blanchard (Rotary Surface)
 - Cylindrical
 - Tool and Cutter
 - Centerless
 - Double-Disc
 - Way Grinding
 - Jig Grinding
 - Drill Sharpening
 - Thread and Gear Grinding
- Grinding Wheels
 - Wheels Marking System
- Coated Abrasives
- Honing
- Lapping
- Super-finishing
- Finishes/Tolerances

Threading

- Equipment
 - Die Heads
- Thread Milling
- Tapping
- Thread Grinding
- Thread and Form Rolling
- Finishes and Tolerances

Gear and Splinning Machinery

- Milling and Hobbing
- Broaching

Non Traditional Machining

- Electro Discharge Machining
 - Wire
 - Sinker
- Water Jet/Abrasive Jet
- Chemical/Electro-Chemical
- Electron Beam Machining
- Plasma Arc Machining
- Finishes/Tolerances

Manufacturing Processes; Week 3

Fabrication

Metal Forming

Rolling

Plate

Bar

Shapes

Drawing

Upsetting (Cold Heading)

HERF (High Energy Rate Forming)

Sheet Metal

Shearing

Punching

Blanking

Notching

Lancing

Fine Blanking

Nibbling

Dinking

Bending

Flanging/Hemming

Roll Bending

Spinning

Machinery

Brakes

Fabrication Centers

Presses

Manual

Mechanical

Hydraulic

Bladder

Press Tooling – Nomenclature

Punch Holder

Punch

Stripper

Die

Die Shoe

Bolster

Guide Pins

Bushings

Press Tooling – Types
Single Die
Multiple Dies
Progressive Dies
Pot Dies
Urethane Dies

Specialty forming

Swaging
4-slides
Straightening

Lubrication

Reasons for lubrication
Types

Calculations
Finishes/Tolerances

Manufacturing Processes; Week 4

Welding and Joining

Weld Processes (Manual, Semi-Automatic, Automatic)

Oxy-fuel Gas Welding and Cutting

Arc Welding

Shielded Metal Arc Welding (SMAW)

Metal Inert Gas Welding (MIG)

Tungsten Inert Gas Welding (TIG)

Sub-Arc Welding

Plasma Welding

Electric-Resistance Welding

Spot

Seam

Solid State Welding

Ultrasonic

Inertia

Diffusion

Forge

Specialty

Laser Beam Welding

Electron-Beam Welding

Vacuum Process

Explosive Welding

Brazing

Torch

Furnace

Dip Brazing

Resistance Brazing

Soldering

Conductive

Convective

Resistive

Induction

Weld Tooling

Fixtures

Shrinkage

Elongation

Bending/movement

Positioners

Tolerances/Finishes

Weld Joints

Fillet – Types

Butt – Types

Stud

Plug or Slot

Spot

Seam

Stitch

Projection

Flash

Butt Resistance

Welding of Materials

Steels

Steel Alloys

Stainless Steels

Brasses/Bronzes

High Temperature Alloys

Aluminum Alloys

Mechanical Fastening

Threaded Fasteners (Bolts, Screws, Nuts, Washers)

Nomenclature

Classification

Fits

Strength

Tightening Torque

Pins

Rivets

Retaining Rings

Stitching

Integral Fasteners

Lanced or Sheared Formed Tabs

Extruded Hole Flanges

Embossed Protrusions

Edge Seams

Crimps

Shrink and Expansion Fits

Heating Process

Cooling Process

Adhesives/Bonding

Chemically Reactive
Evaporative
Hot Melt
Delayed Tack
Film
Pressure Sensitive
Tolerances/Finishes

Manufacturing Processes; Week 5

Surface Preparation/Cleaning/ Finishing/Painting

Surface Preparation

Mechanical

- Polishing and Buffing
- Barrel and Vibratory Finishing
- Spindle Finishing
- Dry Blasting
- Wet Blasting
- Shot Peening
- Power Brushing
- Roller Finishing
- Deep Rolling

Chemical/Electro-Chemical

- Electro-polishing
- Chemical Polishing

Cleaning

Chemical Cleaning

- Dipping
- Spraying

Compounds

- Solvents
- Alkaline Detergents
- Acid Detergents

Pickling

Rinsing

Flame Cleaning

- Thermal Deburring

Steam Cleaning

Vapor Degreasing

Ultrasonic Cleaning

Finishing

Chemical

- Etching
- Bonderite
- Alodine
- Iridite
- Phosphatizing
- Passivation (Stainless Steels)
- Black Oxide

- Blueing
- Teflon Coating
- Dry Film Lubrication
- Electrolytic Oxides (Anodizing)
 - Sulfuric Acid Anodize
 - Chromic Acid Anodize
 - Hard coat Anodize
- Electroplating
 - Copper Plate
 - Cadmium Plate
 - Chromium Plate (Bright, Hard, Black)
 - Nickel Plate (Bright, Black, and Chromium-Nickel)
 - Gold Plate
 - Silver Plate
 - Tin Plate (Tin-Cadmium, Tin-lead, and Tin-Nickel)
 - Indium Plate
 - Rhodium Plate
 - Palladium Plate
 - Zinc Plate
 - Lead Plate
- Hot-Dip Plating
 - Hot-Dip Tin
 - Hot-Dip Zinc
 - Hot-Dip Aluminum
 - Hot-Dip lead

Painting

- Enamels
- Lacquers
- Epoxies (one and two-component Systems)
- Varnishes
- Latex/Water Based
- Electro-Static

Environmental Concerns

Human Factors

Manufacturing Processes; Week 6

Casting/Molding/Forging/Extrusion of Metals

Castings

Advantages

- Difficult to machine or weld product
- Complex shapes
- Internal Cavities

Disadvantages

- Not Anisotropic
- Porosity
- Poor surface finish
- Poor Dimensional Control

Nomenclature

- Pattern
- Cope
- Drag
- Sprue
- Runner
- Gates
- Riser

Multiple Use Pattern/Single-Use Molds

- Green Sand Casting
- Shell Molding

Single Use Pattern/Single Use Mold Process

- Investment Castings
- Evaporative (Lost Foam) Castings

Multiple Use Mold Processes

- Permanent Mold Castings
- Die Castings
 - Hot-Chamber Machines
 - Cold-Chamber Machines
- Die Casting Molds
 - Single, multiple molds
 - Materials
 - Cores
 - Ejector Pins
 - Mold Details
 - Threaded Holes
 - Ribs
 - Wall Thickness

Shrinkage
Finishes/Tolerances

Centrifugal Castings
Advantages
Machinery
Tooling

Powdered Metals

Powder Manufacturing
Blending
Compacting
Sintering

Forgings

Benefits
Forging Types
Open die
Blocker-Type Impression
Conventional-Type Impression
Precision-Type Impression

Forging Hammers
Gravity
Double-Acting
Counter-Blow

Forging Presses
Mechanical
Hydraulic
Screw

Finishes/Tolerances

Extrusions

Advantages and Limitations
Shapes
Lot Sizes
Materials for Extrusion
Equipment
Presses
Automation
Handling Devices
Tooling

Manufacturing Processes; Week 7

Extruding/Molding/Laminating/Forming of Plastics and Composites

Extruding

- Materials
 - Machinery
 - Extruders
 - Screws
 - Barrels
- Tooling
- Finishers/Tolerances

Blow Molding

- Materials
- Extrusion blow Molding
- Injection Blow Molding
 - Machinery
 - Tooling
- Finishes/Tolerances

Injection Molding

- Materials
- Machinery
- Tooling
- Finishes/Tolerances

Reaction Injection Molding (RIM)

- Materials
- Machinery
- Tooling
- Finishes/Tolerances

Thermoforming Plastic Sheet and Film

- Materials
- Machinery
- Tooling
 - Vacuum forming
- Finishes/Tolerances

Rotational Molding

- Materials
- Machinery
- Tooling
- Finishes/Tolerances

Plastic Casting

Materials
Machinery
Tooling
Finishes/Tolerances

Compression Molding

Materials
Machinery
Tooling
Finishes/Tolerances

Transfer Molding

Materials
Machinery
Tooling
Finishes/Tolerances

Composites

Laminating

Machinery
Tooling
Finishes/Tolerances

Filament Winding

Machinery
Tooling
Finishes/Tolerances

Pultrusion

Machinery
Tooling
Finishes/Tolerances

Resin Transfer Molding

Machinery
Tooling
Finishes/Tolerances

Manufacturing Processes; Week 8

Electronic Manufacturing Processes and Review

Electronic Manufacturing

Printed Circuit Board Fabrication
Through-Hole Technology assembly
 Axial-Lead components
 Radial-Lead Components
 Single (SIP) or Dual (DIP) In-Line Packages
Wave Soldering

Surface Mount Technology Assembly
Reflow Soldering

Review

Manufacturing Processes; Week 1
Material Removal Processes I

Manufacturing Processes; Week 2
Material Removal Processes II

Manufacturing Processes; Week 3
Fabrication

Manufacturing Processes; Week 4
Welding and Joining

Manufacturing Processes; Week 5
Cleaning/Deburring/Plating/Finishing

Manufacturing Processes; Week 6
Casting/Molding/Forging/Extrusion of Metals

Manufacturing Processes; Week 7
Casting/Molding/Laminating/Welding of Plastics and Composites

Manufacturing Processes; Week 8
Electronic manufacturing