

- c. Plate protractors
- 5. Precision Measuring Tools
 - a. Micrometers
 - 1. Advantages & disadvantages
 - 2. Calibration & care
 - 3. Outside (1-12 inch)
 - 4. Depth
 - 5. Specialty types & uses
 - (a) Tube and multi-anvil
 - (b) Blade and flange
 - b. Transfer measuring tools
 - 1. Small hole gages
 - 2. Telescoping gages
 - c. Vernier Protractor
 - d. Fixed Gages
 - 1. Advantages & disadvantages
 - 2. Materials & construction
 - 3. Types and selection
 - (a) Plug, ring and snap gage, thread plug
 - (b) Thread plug and ring gage
 - e. Indicators
 - 1. Travel (dial indicators)
 - (a) Use, components, care & attachments
 - 2. Test indicators
 - (a) Use, components, care & attachments
 - (b) Cosine error
 - 3. Dial bore
- C. Hand Tools
 - 1. Hammers- soft & hard face
 - 2. Clamps - "C" and parallel
 - 3. Wrenches -
 - a. Adjustable
 - b. Open end and box
 - c. Allen
 - 4. Screwdrivers
 - 5. Hacksaw
 - a. Set
 - b. Pitch
 - c. Kerf
 - d. Blade materials
 - e. Use and techniques
 - 6. Files - types, shapes, sizes, tooth patterns
 - 7. Layout
 - a. Layout dye - application
 - b. Tools - scribes, combination squares, dividers, prick and center punches
 - c. Layout table and precision height gage
 - 8. Threads & Threading
 - a. Overview of thread systems and uses
 - 1. Metric
 - 2. Unified, American National Standard
 - (a) Series
 - (b) Size designation
 - 3. American National Acme
 - 4. Square Thread
 - 5. British Standard Whitworth Thread
 - 6. International Metric Thread (ISO)
 - 7. Buttress Thread
 - 8. Rolled Thread
 - (a). Roll form taps
 - (b). Roll form tap drill sizes
 - 9. Pipe
 - b. Thread forming with taps
 - 1. Tap types - taper, plug, bottom, spiral point

2. Tap drill selection and hand threading
 - c. Thread forming with dies
 1. Split adjustable
 2. Screw plate
 3. Rethreading
 - d. Broken tap removal
 - e. Re-threading dies
- D. Pedestal Grinders
1. Wheel replacement, ring testing and dressing
 2. Guard settings
- E. Drill Presses
1. Types, components and applications
 2. Basic set-ups and operations
 3. Speed & feed selection
 4. Twist drills, center drills, reamers, counter bores, countersinks
 - a. Drill sizing system
 - b. Tool nomenclature, shank types, applications
- F. Cutting Tool/Workpiece Speed and Feed Calculations
1. Twist drills, center drills, reamers, counter bores, countersinks
 2. Milling cutter RPM and feed rate
 3. Lathe RPM and feed rates
 4. Coolant selection
- G. Lathes
1. Types and applications
 - a. Engine
 - b. CNC-controlled
 2. Components and size designation
 3. Definition of operations - turning, tapering, boring, facing, threading, form turning, and knurling.
 4. Spindle nose types
 5. Tailstock tooling - centers and chucks
 6. Spindle nose tooling, types and applications
 - a. 3 and 4 jaw chucks
 - b. Collets and closer
 - c. Face plates
 - d. Centers
 - e. Mandrels
 7. Lathe cutting tools
 - a. Overview of tool materials
 - (1) High-speed
 - (2) Carbide
 - b. Relief & rake angles for a general purpose tool
 - (1). Applications for rake angles (positive & negative)
 - (2). Application of tool nose radius
 8. Carbide inserts and holders
- H. Vertical Milling Machines
1. Components and applications
 2. Basic machine set-ups and machining operations
 3. Cutting tool selection
 - a. End mills
 - b. Fly cutters
 - c. Form cutters
 4. Shank types
 - a. End mills
 - b. Ball and corner rounding
 - c. Angle
 - d. Fly cutter
 5. Arbor driven
 - a. Shell
 - b. Plain
 - c. Side and slitting
 - d. Angular and form
 6. Offset boring and facing head
 7. RPM calculation and machine speed setting

8. Climb & conventional milling
9. Boring Operations
 - a. Boring applications and advantages.
 1. Size control, finish, concentricity
 2. Boring, facing, grooving
 3. Single point threading
 - b. Boring bars for lathe and basic cutting tool geometry
 - c. Offset boring heads and applications.
 - d. Facing heads: uses
- I. CAM (Computer Aided Manufacturing) system and processes overview
 1. CAD drawing transfer to CNC program
 2. Tool path generation and code produced by CAM program
 3. Post processing to G&M code
 4. Introduction to Computer Numerical Control (CNC)
 - a. History
 - b. Relationship to manual machines
 - c. NC machine types and applications
 - d. CNC programmed operations
 - (1). Straight and angular moves
 - (2). Circular interpolation
 - (3). Canned cycles
 - (4). Sub routines
- J. Computer Numerical Control (CNC)
 1. CNC System Components
 - a. Computer
 - b. Drive motor types
 - c. Open and close loop systems
 - (1). Transducers
 - d. Feed mechanism types
 - (1). Recirculating ball screws
 - (2). Pneumatic and hydraulic
 - f. Data mediums
 - (1). 1 inch tape and readers (historical reference)
 - (2). Magnetic tape and floppy disk and readers
 - (3). Manual data input (MDI)
 - (4). Direct numerical control (DNC)
 2. Mill axis and machine interpretation
 - a. Cartesian coordinate system
 - (1). Mill axis designations (X,Y, Z, A,B, & C)
 - (2). Four and five axis mills
 - b. Lathe X, Z, U and W axis and machine interpretation
 - c. Incremental and absolute programmed moves
 3. Work holding
 - a. Vise and stop
 - b. Strap and toe clamps
 - c. Collet and V-blocks
 - d. Introduction to fixtures
 - (1) Uses and components
 - (2) Production milling methods
 - a. String, progressive and reciprocal
 4. Mill CNC Controller
 - a. Down load from PC
 - b. Zero - return machine
 - c. Basic controller functions
 - d. Use jog functions to accurately locate spindle
 - e. Input and operate in MDI
 - f. Call up and run programs in memory
 - g. Run tool tryout with single block and adjusted feed rates
 5. CNC Mill Set-Up Procedures.
 - a. Workpiece/fixture alignment
 - b. Location and setting of workpiece/fixture zero

VI. Assignments

- A. Lab projects demonstrating mastery of skills using the machines and equipment covered in this course.
- B. Take home worksheets involving calculations
- C. Reading from textbooks and references

VII. Methods of Evaluating Objectives

- A. Two objective examinations covering lecture material and lab demonstrations
- B. In-class quizzes on current and past lecture and lab material
- C. Completion of take-home worksheets
- D. Completion of laboratory exercises
- E. A comprehensive, objective final exam

VIII. Texts and Supporting References

- A. Texts:
 - 1. *Kibbe, Richard, John Neely, Roland Meyer and Warren White. Machine Tool Practices, New York: Wiley & Sons, 2002.
 - 2. *Engle, Michael, Manufacturing & CNC Staff: Manufacturing and CNC 71 Syllabus. DeAnza College, Cupertino; 2003
- B. References:
 - 1. Jones, Franklin and Erik Oberg: Machinery's Handbook. New York: Industrial Press, 2000.