SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

Course Title: WORKSHOP TECHNOLOGY - THEORY & SHOP

Code No-: MCH 107-12 & MCH 117--5

Program: MACHINE SHOP

Semester: 1

Date: October, 1982

Author: Ed Caple

New: Revision: x

APPROVED: <&* S&^ZFJ>

Chairperson Date

Sault College
of .Applied Arts and Technology
sault ste. marie.

Course - Outline

.',-'/,-. MACHINE; SHOP .- .. . #.. ';

MCH 107-12 WORKSHOP TECHNOLOGY

MCH 117-5 MACHINE SHOP (THEORY)

revised OCTOBER 4, 198?—B*4_E. CAPLE

MACHINE SHOP

SAULT COLLEGE

KEYS TO SUCCESSFUL MACHINING

1. A complete understanding of measurement and machine operation.
2. Rigidity of machine - work and tool.
3. Proper tool selection as to type, form, shape, size.
4. Keen cutting edge on all tools.
5. Tool setting relative to work axis (lathe).
6. Speed and feed selection.
7. Understanding of materials.
8. Sense of proportion.
9. Confidence, but respect for machinery and tools.
10. An appreciation for values, i.e. materials, surface finishes - quality and precision, quantity economics as to time, material, dollars and cents, and physical energy.
11. Operation sequence is vitally important.
12. Operators dexterity and co-ordination of individual faculties (Concentration) and (Planning the next step) utilization of all senses, eyes, ears, smell, touch and mind.

G. E. Caple

SAFETY IN THE MACHINE SHOP

1. Always wear safety glasses before attempting to operate any machines in the Machine Shop.
2. Before starting a machine, be sure you know how to shut it off.
3. Never attempt to operate a machine before you fully understand its mechanism.
4. Never wear loose clothing around machines. Remove ties and roll up sleeves to the elbows.
5. Do not wear rings, watches or loose articles which could be caught in machinery.
6. Always stop a machine before measuring, cleaning, oiling or making any adjustment.
7. Never attempt to stop a machine with your hands.
8. Never attempt to remove cuttings with your hands.
9. Always keep the floor free from oil, grease, tools and metal cuttings.
10. Never operate a machine unless all safety guards are in place.
11. Never have more than one person operating a machine at one time.
12. Avoid horseplay. A simple or innocent joke could lead to a serious, painful injury.
13. If injury occurs, get First Aid immediately.

REFERENCE TEXTS

Machinist Hand Book - Erik Oberg, F.D. Jones, Industrial Press

Shop Theory - Henry Ford Trade School, McGraw-Hill

Machine Tool and Metal Working - Feirer & Tatro, McGraw-Hill

Technology of Machine Tools - Krar et al.s McGraw-Hill

Machine Shop Operations & Set Up - Porter-Lascoe & Nelson
American Tech. Society

Machine Tool Operation - Vol. 1 - Burghardt et al., McGraw-Hill

Machine Tool Operation - Vol. 2 - Burghardt et al., McGraw-Hill

TEXTS

Machine Shop Training - Krar & St. Amand, McGraw-Hill

Technology of Machine Tools - Krar et al., McGraw-Hill

WORKSHOP TECHNOLOGY

This course is designed to associate the student with general machining principles and familiarize him with the new and modern techniques, involving the operation and use of the latest machine shop tools, instruments and equipment.

For the grade 12 secondary school machine shop graduate, the course will challenge and complement him to be a select machinist apprentice for any progressive minded industry.

The course amply provides for those wishing to become involved in any of the multitude of related areas of machine shop work, i.e. inspectors, set-up men, programmers, lathe hands, specialists, operators, etc.

In an attempt to speed up and cover the heavy load of material, the text (Machine Shop Training by Krar & St. Amand) is speedily reviewed, before an intensive and detailed study of the two volumes of Machine Shop Operations are managed. Many fundamentals have been incorporated in various projects and assignments, but for the more aggressive student, the freedom of research and experimentation is available.

Safety hazards and precautions are exposed and stressed rigorously and to condition the students to simulated industrial surroundings, a shop foreman is selected weekly to inject a sense of responsibility.

INTRODUCTION: The course will consist of lectures, practical assignments and demonstrations covering the following topics.

MACHINE SHOP

TOPIC INFORMATION

Organization

(a) Orientation
(b) Course outline
(c) Safety rules
(d) Shop rules & regulations
(e) Shop machines

Mensuration

(a) Steel rules and caliper use
(b) Decimal systems
(c) Micrometers
(d) Verniers
(e) Intrimikes

Layout

(a) Definition and surface preparation
(b) Layout table 7 supplementary tools
(c) Set-up and application
(d) Parallels - V Blocks - angle plates

Hand Tools

(a) Types and selection
(b) Bench work
(c) Handling and care of tools
(d) Taps and dies
(e) Metal fasteners
(f) Fitting and assembling
(g) Broaching

Power Saws

(a) Types and parts of saws
(b) Reciprocating power hack saw
(c) Band saw
(d) Circular saw
(e) High speed, steel, cut-off saw
(f) Materials
(g) Speeds and feeds

Drill Presses

(a) Types and parts of drill presses
(b) Drill holding devices
(c) Work holding devices
(d) Cutting fluids
(e) Operations-drill and tap, ream, bore, spot face, counter bore, trepanning, flowering-lapping, etc.
(f) Drill sizes and selection
(g) Speeds and feeds
(h) Drill grinding

TOPIC INFORMATION

Lathes

(a) Parts and their function
(b) Speed and feed selection
(c) Materials
(d) Work holding devices
(e) Mounting and setting up work
(f) Mounting and setting up tools
(g) Tools and tool bit grinding
(h) Basic operations
(i) Taper turning
(j) Threads and thread cutting
(k) Boring operations
(1) Face plate set-up
(m) Steady and follower rests
(n) Jigs and fixtures
(o) Eccentries
(p) Ball turning
(q) Mimik Tracing
(r) Milling attachment
(s) Metric thread cutting
(t) Thread rolling
(u) Carbide tooling and use

Pedestal Grinder

(a) Truing and dressing wheels
(b) Tool bit grinding
(c) Reconditioning hand tools
(d) Wheel selection
(e) Safety

Shapers

(a) Types and parts of
(b) Str

BLOCK: Benches

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To observe Safety precautions.	Safety precautions. Methods of cleaning tools Importance of keeping tools in good condition. Tool storage methods to avoid damage to tools.	Cost of tools
To hold workpiece in a: - vise - clamp to a bench - angle plate - fixture	Types of Vises. Parts of Vises.	
To change a Hacksaw Blade.	Types, Speed, and proper selection of hacksaw blades for various materials.	
To use a hand hacksaw to: - cut off a piece of material. - saw a slot. - saw to a layout line	Procedure for welding a bandsaw blade.	
To chip a surface flat. To chip a keyway. To chip an oil groove. To shear with a chisel. To file to a contour. To file a shoulder. To file a surface flat. To file an internal surface. To draw file. To file at right angles.	Types of Cold Chisels. Methods of using a Chisel on different surfaces. Sharpening chisels to recommend cutting angles. Types of chisels steels, hardening and tempering. Types of nomenclautre of files. Cleaning and care of files Methods of filing and holding.	Types of power chisels and their use,

BLOCK: Benches

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To hammer a piece of material into shape.	Correct method of holding a hammer.	Methods of reconditioning a hammer head.
To check a casting by hammering it.	Types, sizes, uses, and weights of hammers.	Types of wood used for hammer shafts.
To poem a rivet.		
To form a piece of material in a vise.		
To polish a work-piece.	Types of abrasives.	
To tap a hole.	Tap sizes and termin-ology.	
To tap a tapered pipe thread.	Types features and sizes of hand dies.	Method of producing hand dies.
To thread a bolt by means of a stack and die.	Thread forms and fits.	Bolt and screw production methods.
To remove a broken tap.	Threading procedures.	
To shear thin metal by means of tinners snips.	Traps, features, and purpose of hard snips.	

BLOCK: Bench Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To bend a workpiece. To twist a piece of metal. To rivet. To straighten or curve thin stock by peening.		
To cut a gasket.	Gasket material.	
To scrape a surface flat.	Methods of marking high spots.	
To scrape a bearing.	Types and use of scrapers	
To deburr a hole by scraping.	Purpose of scraping.	
To frost or feather a surface.	Scraping procedures and surface finishes.	
To drill a hole by means of a portable drill.	Common drill sets and nomenclature.	
To sharpen a scraper.	Types of sharpening stones.	
To deburr a hole with a hand drill.	Cutting angles of drills. Types and sizes of portable hard drills.	Maintenance of portable drills
To ream a hole.	Types, features, and uses of hand reamers.	
To ream a tapered hole.	Types, sizes, and uses of screwdrivers and wrenches.	
To assemble workpieces with screws and dowels.		
To clamp two or more pieces together.	Types of clamps.	
To splice a belt.	Types of belt weaving.	
To remove a gear with a wheel puller.	Types and applications of wheel pullers.	
To press a mandrel into a workpiece.	Types of mandrels. - Mandrel tapers	
To fit two pieces together.		
To lap a surface.	Preparation and care of laps.	
To check surface flatness.	Methods of using laps.	
To lap a hole parallel		
To lap or stone a flat surface.	Sizes, shapes, and grades of hones. Method of honing or stoning.	Types of honing machines.

BLOCK: Bench Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To hone or stone an edge on cutting tools-		
To soft solder. To silver solder.	Composition of solders.	
To pierce a hole with a rotary punch,	Standard sizes of rotary punches.	
To remove a dowel pin.	Types, sizes* and use of drift punches. Types of punch steel used and ideal hardness.	
To mark with stamps.	Types, sizes, and purpose of metal stamps. Use of reverse stamps on dies and molds.	
To Etch,	Method of using electrical etchers. Method of etching by the use of wax and acid.	Principles of electrical etching, Types of acid.
To file in a filing machine.	Methods of holding work, setting speeds, and setting the angle of the table.	Types of filing machines.
To broach a keyway.	Broach nomenclature. Types and sizes of broaches. Broaching procedure using an arbor press.	Broach steel
To grind with an electric hand grinder.	Types and sizes of hand grinders. Sizes and shapes of grinding wheels. Bonds and grades of grinding wheels.	Maintenance of electric hand grinders.

BLOCK: Layout Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To select a layout table.	Types and features of layout tables.	
To select a layout plate.	Advantage of cast iron and granite layout plates.	
To prepare a surface for layout.	Methods of cleaning and and degreasing the work. Methods of preparing a surface.	
To apply layout dye.	Types of layout dyes.	Composition of layout dyes.
To scribe a line.	Need for sharp lay-out tools.	
To prick-pinch a proof line.	Types of centre and prick punches.	
To centre punch.		
To layout with a solid square.	Use and application of witness marks.	
To layout with hernia' phrodite calipers.	Types of holding devices: - "V" Blocks - Angle plates - Clamps - Holding Fixtures	
To layout with a combination square,		
To layout with dividers.		
To layout with trammals.		
To layout with a centre-head.	Methods of establishing centre points.	
To layout with a vernier protractor,		
To layout with a height gauge.	Mathematics to calcu-late angles and chorda! distances.	

BLOCK: Layout Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To layout on a surface plate.		
To layout with a sur face gauge.		
To layout with the work in a "V"-block.	Geometrical method of checking lines with arcs, disks* and circles.	
To layout with an angle plate.		
To layout an hexagon	Method of obtaining sizes with gauge clocks.	
To layout a square.		
To layout an edge cam,	Generation of a cam plot,	
To layout a keyway in a bore or on a shaft.		
To layout a casting for machining.	Using chalk as a layout dye.	
To layout with a sine bar.		
To set up with tool-makers buttons.	Blueprint readings and interpretation of specifi cations.	
To set up an angle on a sine plate or sine bar.	Layout procedures.	
To check a layout.		
To layout to a template.		
To layout angles using a protractor.	Bending allowance and method of computation,	
To divide a circle into equal parts.	Geometry of circles.	
To layout using a rotary table.		

BLOCK: Measuring Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To observe Safety precautions.	Safety precautions. Care and precautions in use of precision i nstruments. Methods of storing precision tools.	Manufacturers and suppliers of precision measuring tools. Types of steel used in precision tools.
To measure with: - Steel Rule - Steel Tape - Outside Micrometer - Inside Micrometer - Depth Micrometer - Thread Micrometer - Vernier Caliper - Vernier Depth Gauge - Vernier Height Gauge - Gear Tooth Vernier	Types and features of rules and tapes. Methods of obtaining accurate measurement. Types and features of micrometers. Reading a micrometer. Methods of adjusting and testing micrometers, Types and features of Vernier scales. Reading Vernier Scales. Application of Vernier scaled tools.	History of the vernier The metric vernier
- Protractor - Universal Bevel Protractor Dial Indicator - Dial Depth Gauge - Shrink Rule - Tool makers micro-scope - Comparator - Reed type compara-tor - Electronic Compara-tor - Three Wire System	Types and features of protractors. Methods of reading Vernier protractors. Types and features of dial indicators. Nomenclature of dial indicators. Principles of micro-scopes. Comparator nomenclature and terminology. Taper trigonometry. The "best" wire method for measuring threads.	Manufacturers and suppliers of thread wire.
Hardness Tester Tensile strength with tensile tester Profilometer	Types and principles of hardness testers. Types and principles of tensile testers. Principle of the pro-filometer.	

BLOCK Measuring Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To check with a: - Plug Gauge - Taper Gauge - Ring Gauge - Caliper Gauge - Telescoping Gauge - Thread Plug Gauge - Thread Ring Gauge - Form Gauge - Snap Gauge - Thickness Gauge - Radius Gauge - Angle Gauge - Wire Gauge - Drill Gauge - Drill Point Gauge - Fillet Gauge - Precision Level - Straight Edge - Thread Gauge - Thread Snap Gauge - Shadowgraph - Optical Flats - Square - Pin Gauge - Woodraff Keyway Gauge - Spline Gauge - Pitch Gauge - Dial Caliper Gauge - Transit	Nomenclature of Gauges. Gauge Standards, design limits and tolerances. Types and uses of gauges. Care and cleanliness to be observed for gauge purposes. Sizes of fillet gauges. Construction of a level Construction of a straight edge. Sizes of screw pitch gauges. Principle of the shadowgraph. Lightwave reflective principle of optical flats. Principle of the transit.	Manufacturers and suppliers of gauges. Construction of the shadowgraph. Construction and finishing of an optical flat.
To transfer measurement with a: - Divider - Outside Caliper - Inside Caliper - Hermaphrodite Caliper - Trammel - Surface Gauge - Angular Gauge Block - Sine Bar - Template	Types and features of dividers. Construction of calipers Methods of setting calipers. Types and features of trammels. Types and classification of gauge block sets. Function of the sine bar Knowledge of the trigonmetrical function of a sine.	Types of steel and methods of finishing a gauge block. Sine Plates and sine chucks.

BLOCK: Jig Borer Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To operate the Jig Borer.	Capabilities of Jig Borers. Jig borer measuring devices. Parts nomenclature.	Manufacturers and suppliers of Jig Borers.
To set speeds and feeds.	Best cutting speeds and feeds for various materials. Methods of adjusting speeds and feeds.	
To mount accessories,	Method of mounting and removing the spindle. Methods of aligning work with the spindle. Types of holding accessories. Types of spindle noses Types of spindle accessories: - Chucks - Drills - Reamers - Offset boring head	
To select a method for holding the work	Method of determining size of: - Work - Holes - Accuracy from Blueprints. Advantages of work holders for particular applications: - Vises - Vise Blocks - Rotary Table - Angle Plates	Strength of materials.

BLOCK: Jig Borer Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To set work.	Types of levelling equipment. Methods of levelling. Method of attaching work to an angle plate. Types of Rotary tables - angular calculations Method of setting up a Sine bar. - Calculations necessary for setting an angle with a sine bar (plate). - Method of using gauge blocks	Knowledge of parallels indicators, and jacks.
To locate work to a spindle centre.	Method of applying locating tools: - Indicators - Gauge Blocks - Edge Finder (Tool-makers chair)	
To set the Jig Borer,	Method of moving the table by use of the: - Micrometer lead screw - Graduated collar - Longtitudinal and Transverse settings Method of setting up a co-ordinate location system.	Determination of angles by "polar" and "Cartesian" system.
To drill and bore.	Fits and tolerances. Standard Drill sizes Allowances for finish boring. Method of boring with a single point tool. Rough boring allowance for a series of holes.	Tolerances for shrink, press, and running fits.

BLOCK: Jig Borer Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To cam, counterbore, and countersink.	Types and standard sizes of Reamers, counterbores, and countersinks. Method of controlling the depth of feed - Setting Stops - Automatic Kick-out	
To accurately measure the machined surfaces,	Knowledge of the use of: - Calipers - Telescopic gauges - Micrometers - Inside - Depth - Outside - Special Tools	

BLOCK: Lathe Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To operate the Lathe controls.	Stop and start buttons, levers, clutches and hand wheels. Parts and care of parts.	Safety, Parts of a lathe. History and development of lathes.
To mount and remove chucks, faceplates, and driveplates.	Locking devices: Plain thread. Taper-key-lock-ring, taper-key-camlock.	Determination of sizes.
To mount and remove centres. To layout for centering with centre-head, hermphrodite calipers.	Types of centres: Soft, hard, tipped, live.	Types of lathes - Turret - Capstan - Engine - Automatic - Screw - Profile
To end face and centre drill	Tool height, position of compound angle of tool holder.	
To align centres,	Methods of alignment.	Point to point. Trial cuts.
To mount work between centres.	Position of tailstock for tool clearance.	Test bar and indicator.
To adjust work between centres	Lubrication of dead centre, adjustment and locking of ram.	Work to be free to avoid overheating, but not too loose.
To drive work between centres.	Slotted drive plate, straight and cranked dogs, clamp dogs.	
To parallel turn between centres.	Trail cut after alignment of centres.	
To set up tool holder and tool bit,	Types and nomenclature of holders.	Determination of right and left hand tools.
To set up speeds and feeds.	Formula rpm = 4 CS	Ferrous and Non-Ferrous metals.

BLOCK: Lathe Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
	Diameter and kinds of material, desired finish calculation of r.p.m.	
To set depth of cut.	Calibration of micro-meter collars.	Rotation of work removed twice the applied depth of cut.
To keep tool bit sharp.	Correct speeds and feeds coolant.	
To rough and finish turn.	Reasons for rough and finish.	Class of work, finish, stock to be received. Safety precautions - protection of lathe ways.
To file and polish.	Lathe file cut angles, sizes, types and kinds of abrasive cloth.	
To taper turn with tail-stock off-set.	Limitations of tail - stock off-set method.	Distortion of centres.
To turn to a shoulder		
To groove with a cut-off tool.	Kinds of grooves: - "Vee" - Clearance - Height - Round - Square - Rake angles	Nomenclature of groove: - Necks - Recesses - Undercuts
To groove with a form tool.	Uniformity for repetition.	Explanation of male and female terms.
To turn a free-hand radius.	Manipulation of longtit-udinal and cross feeds combined.	Definition of "free-hand".
To cut a radius with a form tool.	Uniformity for repetition.	
To cut a radius with a radius attachment.	Reason and set-up for attachment.	Radius too large for form-tool. Single point tool eliminates tear and chatter.
To taper or angle turn with an attach-ment.	Calculation of taper per foot or degree of angle. Compound feed.	Function and reason attachments. Names of parts.

BLOCK: Lathe Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To taper or angle turn with a compound.		
To knurl.	Height of tool, lubri cation, speed.	Explanation of cor- rect, tracking for clean diamond pattern Straight knurl, Pitch of Knurls,
To machine tap	Floating socket for tap alignment.	
To sharpen tool bits	Cutting angles, clear- ance, rakes kinds of material.	
To part off.	Accuracy of set-up, position of cut from chuck.	Condition of spindle bearings, kind of material, straight and off-set tools.
To drill and Ream.	Speed, Feed, Lubrica- tion, Floating Socket,	
To bore.	Design of tool, care in set up.	Undue hang-over causes chatter.
To cut internal threads.	Position of compound, set-up of tool.	
To end face between centres.	Cut away dead centre.	Limited to small amount of stock removal.
To bore a taper.	Compound or attachment,	
To cut an internal groove.	Design of tool, care in set up.	Need for internal grooves, lubrication, clearance, strength.
To trepan.		
To set up work on a face plate.	Correct clamping, pro- tection of work, clear- ance and safe set-up correct balance.	Holding Devices. Purpose of treppaning reduce waste and time, saves material.

BLOCK: Lathe Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To set up work on an angle plate.		
To protect work from clamp damage.	Packing of drive dogs, chuck jaws, faceplate clamps.	Types of angle plates fixed and adjustable.
To engage back gearing.	Withdrawal of drive pin on belt diven lathes.	Not required on modern geared head lathes due to reduction gear box.
To hand ream and hand tap.	Limited to clutch operated lathes where spindle control is positive.	
To taper turn with a square nosed tool	Limited to lathes in good condition and only as a last resort.	
To grind in a lathe,	Speed and direction of grinder spindle.	Heavy cloth or leather to cover ways.
To calculate gears for thread cutting.	Formula: $\frac{\text{Lead}}{\text{Number}} \quad \frac{\text{Driven}}{\text{Follower}}$	Explanation of lead screw to threads per inch.
To set a Quick Change Gear Box for thread cutting.	Position of levers for Threads per inch to be cut.	Wide range of possible threads per inch on modern lathes compared to old.
To cut a thread, To operate a thread dial.	Set up of tool with gauge. Angle of compound. Calculation of thread depth. Reason for dial for even and odd threads.	Explanation of fractional threads
To change gears	Ratio between spindle gear and lead screw.	
To set up a gear train.		

BLOCK: Lathe Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To eliminate back-lash in a lead screw,	Avoidance of incorrect settings.	Reason due to wear.
To mount and set a steady-rest.	Reason for rest - Reduce chatter, prevent whip, support and centralize.	Versatility of lathe restricted without rests.
To mount and set follower-rest.		
To form-cut.	Uniformity for repe-tition.	
To turn on a mandrel.	Concentricity of work quick set up for production.	Types of mandrels: - Plain - Tapered - Splined - Expanding
To turn an eccentric.	Offset equals throw centre-line to centre-line.	Quick concentric set-up.
To set up a collet or spindle chuck.	Draw-bar and taper type.	
To set work concen-tric in a four jaw chuck.	Methods: - Chalk - Scriber - Vliggler - Indicator	Versatility of chucks for irregular shapes.
To pick up or catch a thread.	Re-setting of tool and compound, rotation of work in centres or chuck manipulation of reverse lever or intermediate gear.	
To cut a thread without a dial.	Engagement of half-nut and reversal of spindle rotation.	
To measure a thread with wires.	Formula: G = 55735 for diameter of wires, and M = D+SG - $\frac{1.5155}{N}$	Effective diameter is that point where thickness of thread equals distance between consecutive threads.

BLOCK: Lathe Work

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To cut a left hand thread.	Position of compound, Tool makes.	
To cut a tapered thread.	Tool set at 90° to axis not to taper.	
To cut a square thread.	Depth of thread equals .5P	Purpose of square and acme threads.
To cut an acme thread.	Lead equals pitch on single threads.	
To cut a multiple thread.	Lead depends on number of starts.	For rapid transmission of power, appearance, strength
To end mill in a lathe.	Limitations depending on type of lathe.	
To cut a keyway or slot in a lathe.	Engagement of back gearing or low speed to "lock" the spindle.	
To cut a face recess,	Speed, hand feed, condition of lathe, set-up of tool.	
To hack end-face on a lathe.	Limited to large bore and small boss section.	

BLOCK: Drill press

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
	Safety precautions appropriate to drilling,	
To mount and remove drills.	Types of drill presses, their parts and features.	How twist drills are manufactured.
To mount work rigid	Types and sizes of drills.	The smallest and largest hole it is possible to drill on a drill press.
To sharpen a drill	Speeds and feed calculations for drillings: R.P.M. = $\frac{4 \times CS}{}$	How holes are produced without the use of a drill: -Air jets - Burning
To drill a hole.	Parts of a drill and clearance angles required.	
To draw a hole concentric to lay-out lines.		
	Causes of drill breakage.	Costs of drill presses.
To ream a hole.		Minimum and maximum cost of drills.
	Clamping devices to secure work variety.	
To spot-face a hole.		
To counterbore a hole.	Vises, "V'-blocks, angle plates, hold-downs, jigs and fixtures.	
To lap a hole.		
To hone a hole,	Cutting lubricants and coolants.	Mensuration.
To bore a hole.	Type of reamers	

BLOCK: Drill Press

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To drill a flat bottomed hole.	Allowances for reaming holes.	
To drill square and hexagon holes.	Press fit sizes for dowels.	
To drill thin sheet metal.	Cutting angles and rake for flycutters.	
To drill non-ferrous metals.	Types of taps,	
To flower a surface.	Tap-drill calculations: Tap-drill size = D - 970 **IT**	
To trepan in a drill press.	Tapping attachments for a drill, press.	
To drill a hole in glass.	Types of fasteners.	
	Types of laps, hones and abrasives.	

BLOCK: Power Saws and Hack Saws

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To change blades.	Safety Precautions	Types of steel in blades.
To measure to length.	Proper blade selection,	
To mount and saw round material.	Types and sizes of power saws.	How saw blade teeth are manufactured.
To mount and saw angle iron.	Coolants and applications.	
To mount and saw thin material and pipe.	Types of saw blades. Teeth per inch and best application.	
To saw material to 45° angles.		
To saw different metals.		

BLOCK: Metal Cutting Band Saw

OBJECTIVE	TECHNICAL INFORMATION	GENERAL INFORMATION
To mount band saw blades.	Safety Precautions.	Types of saw blade steels.
To adjust tension and position the saw blade.	Band saw parts and their function.	How saw blade teeth are manufactured.
To weld band saw blades.	Proper blade selection.	Development of the Band Saw.
To saw flat plate.	Cutting speeds and feed selection.	
To saw to lay-out lines.	Table and vise tilting mechanism.	Advantages of a band saw over a reciprocating back saw.
To saw contours.	Holding devices while sawing.	
To saw out washers and internal sections.	Measuring the length of a new saw blade.	How to fold and store band saw blades.
To saw out sections for models.		Tempering heats for various materials.
To file in a Do-all band saw.		
To hone in a band saw.		
To polish in a band saw.		
To friction saw hardened materials.		