

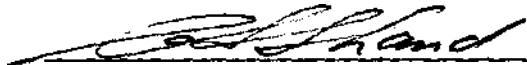
SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY
SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

Course Title: WORKSHOP TECHNOLOGY - THEORY & SHOP
Code No-: MCH 118-5 & MCH 120-12
Program: MACHINE SHOP
Semester:
Date: _____ October, 1982
Author: ^{Ed} Capie

New: Revision: x

APPROVED



Chairperson

Date

T*

Sault College of Applied Arts and Technology sault ste. marie

Course Outline

MACHINE SHOP

MCH 120-12 (WORKSHOP TECHNOLOGY)
- SHOP

MCH H5-40 (WORKSHOP TECHNOLOGY)
- THEORY

MACHINE SHOP

Complimentary:

Although study will continue into more complex fields of the various machines, tools and instruments the use of the first semester knowledge will be utilized in the new areas, and the student will be responsible for both semesters work as a unit in his final assessment.

MACHINE SHOP

| TOPIC NO | PERIODS | TOPIC INFORMATION |
|----------|---------|--|
| 10 | 40 | <p>Milling Machines</p> <ul style="list-style-type: none"> (a) Types and parts of and safety (b) Cutters (c) Dial indicators (d) Operations, basic (e) Work holding devices (f) Adaptors & accessories (g) Dividing head (h) Gear cutting {i Mimik milling (j) Special indexing and milling operations (k) Rotary tables (l) Helical & spiral milling |
| 11 | 40 | <p><u>Precision Layout and Inspection</u></p> <ul style="list-style-type: none"> (a) Vernier height gauge & pi a check gauge (b) Gauge blocks (c) Sine bars, plates and tables (d) Vernier gear tooth caliper (e) Thread wires {f Surface finishes (g) Profilometer (h) Visual comparator (i) Optical comparator (j) Optical flats (k) Optical flats (l) Gauges and templates (m) Fits - tolerances - allowances |
| 12 | 25 | <p>Trava-Dial Grinders</p> <ul style="list-style-type: none"> (a) Safety (b) Bench & pedestal grinders (c) Hand grinders & sanders (d) Surface grinding (e) Grinding wheel selection (g) Cylindrical grinder (parts of) (h) Internal and external (h) Grinding tapers (i) Grinding tapers (j) Form grinding (k) Tool & cutter grinder (l) Sharpening cutters (m) Coolants (n) Diamond grinding wheels for carboloy grinding Form dressing |

MACHINE SHOP

| <u>TOPIC NO.</u> | <u>PERIODS</u> | <u>TOPIC INFORMATION</u> |
|------------------|----------------|---|
| 13 | 20 | <u>Heat treatment</u> (a) Definitions (b) Furnaces - operation (c) Pyrometers (d) Materials (e) Forgin (f) Hardening-tempering, annealing, normalize case hardening (g) Metcalf's Experiment (h) Hardness testing (i) Microscopic Inspection |
| 14 | 25 | <u>Jig Bore</u> (a) Parts & operation of (b) Precision measuring system (c) Co-ordinate layout & calculations (d) Adaptors & accessories (e) Precision boring heads (f) Work mounting (g) Edge finding (h) Indicating, Wiggler, edge finder, microscope |
| 15 | 25 | <u>Punch Press & Die Work</u> (a) Parts & operation of (b) Safety (c) Terminology (d) Parts of & types of dies (e) Design & layout (f) Mounting dies |
| 16 | 20 | <u>Special Processes</u> (a) Electric discharge machining (b) Digital Readout (c) Numerical control (d) Toolmaking (e) Manufacturing methods <u>Miscellaneous</u> (a) Lubrication (b) Formulae A calculations (c) Gear terminology (d) Thread Wires & gauges (e) Toolmakers buttons (f) Keys & Keyways (g) Tables & charts |

BLOCK: Milling Machine Work

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|------------------------------------|--|--|
| | Parts of a milling machine and their function. | Types and sizes of milling machines. Manufacturers and suppliers. |
| To lubricate a milling machine. | Lubricants and application devices. Purpose and grades of various lubricants. Safety practices appropriate to milling operations. | Manufacturers codes and classification of lubricants. |
| To mount an arbor, | Types and sizes of arbors. Purpose of draw-in bolt. | Milling machine arbor "fast" taper and its purpose. |
| To mount an arbor support. | Methods of supporting an arbor. | |
| To mount a milling machine cutter. | Cutter types and their applications. Selection of cutters. Methods of holding cutters. Drives for cutters. Use of arbor spacers. | Types of tool steels used for cutters. Clearance for cutting effectiveness and wear resistance. Carbide tipped cutters Disposable cutter tips |
| To mount a fly-cutter, | | |
| To mount a boring head. | | |
| To calculate speeds and feeds. | Various feeds and speeds for different materials | |
| To set speeds and feeds. | | Principles of various feed mechanisms: - Mechanical - Hydraulic - Rapid Traverse |
| To set table stops or limits. | | |

BLOCK: Milling Machine Work

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|---|--|---|
| To conventional mill | Advantages & disadvantages. | |
| To climb mill | Theory of climb milling. Precautions to recognize, Advantages & disadvantages. | |
| To mount a vertical attachment. | | |
| To align a vertical attachment. | Types of indicators and holders. | |
| To mount a drill chuck. | | |
| To mount an end mill | | |
| To mill a slot. | | |
| To mill a "T" slot. | | |
| To mill a dovetail. | Application of formula for measuring dovetail | Development of dovetail formula. |
| To mill a radius. | | |
| To mill a fillet. | | |
| To mill a keyway - Standard keyway - Woodruff keyway. | Types of keys, standard sizes, and tolerances. | |
| To mill to a layout. | Methods of "laying out". | Types of layout dyes and their application, |
| To form mill. | | |
| To part with a slitting saw. | Hold down precautions | |
| To mill a serration. | | |
| To drill. | | |
| To bore. | | |

BLOCK: Milling Machine Work

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|--|--|---|
| To set up a gear train for compound gearing. | Method of calculating compound gearing. | |
| To set up a gear train for helical cutting. | Method of calculating the lead of a helix. | Trigonometrical functions. |
| To cut a helical groove. | Calculating the table angle and method of centering the cutter. | |
| To slab mill. | Advantages of Halical toother cutters. | |
| To clamp work to the table. | Methods of holding and stabilizing the work. Types of clamps and holding bolts. Types of hold-downs. | |
| To mount a vise. | Use of aligning keys. | |
| To mount work in a vise. | Methods of holding work down. Correct use of parallels and fillers. | |
| To mount an angle plate, | | |
| To mount work on an angle plate. | | |
| To mount work in "V" blocks. | | |
| To mount a dividing head and tail stock. | Calculations for indexing: - Simple - Compound - Differential | Theory of the operation of a dividing head. |
| To mount work in a dividing head. | | |
| To mount work on parallels. | Types of parallels - Straight - Box - Adjustable - Step | Limits of accuracy of parallels. |

BLOCK: Milling Machine Work

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|---|--|--|
| To mount work on parallels using shims and paper packing. | | |
| To mount a rotary table. | | |
| To mount work on a rotary table. | | |
| To set depth of cut. | Measurement increments of the graduated collar, | Maximum cut per tooth. |
| To cut a gear or any toothed member, | Method of calculating the table angle. Method of centering the cutter. | Theory of gear tooth generation. |
| To cut a spline. | | |
| To mill a cam. | Method of inclining the dividing head to reduce lead. | Trigonometrical Tables. |
| To mill an angle. | | |
| To mill a thread. | | |
| To mount a slotting attachment. | | |
| To mount slotting tools. | Shapes of slotting tools Rakes and clearance angles for most efficient cutting. | Tool steel requirements for cutting tools. Hardening and tempering techniques and procedures. |
| To slot a square. | | |
| To slot an internal radius. | | |
| To slot an external radius. | | |

BLOCK: Shaper Work

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|--------------------------------------|---|---|
| To lubricate the Shaper. | Parts of a shaper and their functions. | History and development of the shaper. |
| To set the tool-holder and tool-bit. | Lubricants and application devices. | Types, sizes, and costs of shapers. |
| To grind a shaper tool-bit. | Types of Tool-holders, General sizes and forms of tool-bits. Clearances for effect-cutting action and wear, | Suppliers and manufacturers of shapers Manufacturers codes for classification of lubricants. |
| To set the clapper box. | Theory and necessity for off-setting the clapper box. | |
| To set the length of ram stroke. | Method of setting the slide gib. | Principle of the cam stroke and quick return. |
| To adjust the ram positioning cam. | Mechanical principles for accomplishing ram positioning. | |
| To calculate and set speeds. | Various speeds and feeds different materials. | Principle of feed mechanisms: Table: Horizontal feed Vertical feed Head: Vertical Feed Automatic Feed |
| To mount a vise. | Use of aligning keys. | Types of Vises: Mechanical Pneumatic and Hydraulic holding devices |
| To mount work in a vise. | Methods of holding work. Method of shaping work square using a round rod, | |
| To set table height, | Determination of collar graduation. | |

BLOCK: Shaper Work

OBJECTIVE

TECHNICAL INFORMATION

GENERAL INFORMATION

To mount work on a table.

Methods of holding work

To mount work on the side of a table.

Types of clamps and holding devices.

To mount work on an angle plate.

Types of hold-downs,

To clamp work against parallels,

Types and sizes of parallels.

Manufacture and tolerances of parallels.

To set up adjustable parallels.

To clamp work on parallels using shims or paper packing.

To clamp work with hold-downs.

Types of hold-downs:

- Finger
- Off-set
- Pinch-down

To align vise by:
- Trial cuts
- Indicator

Knowledge of increments of indicator measurement.

To align work with an Indicator.

To grind, mount, and use forged tools

Tool grinding for clearance.

- Parting Tool
- Goose-neck Tool
- Special Formed Tool

Types of tool steels. Theory and method of hardening and tempering tool steels.

To part in a shaper.

To shape a slot.

To shape a "T" slot.

To shape with a formed tool.

BLOCK: Shaper Work

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|--------------------------------------|---|--|
| To machine a roughing cut. | | |
| To machine a finishing cut. | Protective methods for finished surfaces. | |
| To shape a flat surface. | Surface finishes and ointments. | |
| To shape a vertical surface. | | |
| To shape parallel surfaces. | | |
| To angle shape by swinging the head. | Knowledge and understanding of angular measurement. | |
| To angle shape by tilting the table. | | |
| To angle shape by rotating the vise. | | |
| To shape a compound angle. | Method of combining the rotating members of a shaper. | |
| To shape a shoulder, | | |
| To shape to a blind shoulder. | | |
| To shape an external keyway. | Standard key sizes and tolerances. | Types and sizes of keys. |
| To shape an internal keyway. | Types of boring bars for internal shaping. | |
| To shape to a layout. | Methods of "laying-out" | Various types of lay-out dyes and their applications |
| To shape a dovetail. | Methods of calculating the size of a dovetail | |

BLOCK: Shaper Work

OBJECTIVE

TECHNICAL INFORMATION

GENERAL INFORMATION

To shape multiple sides.

Theory of indexing with a dividing head.

To shape a contour,

Theory and principle of tracing attachments.

To shape a radius.

To shape a "V" groove

To shape a gear or rack.

Method of calculating gear measurements.

To shape a serration.

BLOCK: Pedestal Grinder

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|---|--|---|
| To start and stop a pedestal grinder. | Names and locations of control devices. | Types of grinders |
| To prepare for using a pedestal grinder. | Method of adjusting guards and tool rests. Knowledge of safety precautions particularly the use of safety goggles. | Manufacturers and suppliers of grinders and grinding accessories. |
| To mount a wheel | Reason for blotters and clamp plate spigot. Types, sizes, shapes, bonds, and grains of grinding wheels. | |
| To sharpen a tool bit. | Rake and clearance of machine cutting tools, Method of checking the rake and clearance by gauges. | |
| To grind a conical surface: - Prick punch point - Centre punch point - Scriber point | Conical or nose angle of punches and scribes. | |
| To sharpen a drill. | Nose angles for drills for drilling various materials: - Soft metal - Machine steels - Hard steels - Wood Method of rotating the work for controlling the angle of the nose. Gauging the nose angle of drills. | |
| To sharpen a carbide tipped tool. | Rake and clearance angles for carbide tipped tools. Types of most appropriate coolants. Types of carbide cutting grinding wheels. | Method of setting carbide tips in holders. |

BLOCK: Pedestal Grinder

| <u>OBJECTIVE</u> | <u>TECHNICAL INFORMATION</u> | <u>GENERAL INFORMATION</u> |
|----------------------------|---|----------------------------|
| To "snag" grind. | Courseness of wheels for snag grinders. Method of holding work by swinging fixtures. (Pendulum fixtures). Safety precautions to recognize i.e. gloves and goggles. | |
| To "spark" test. | Identification of metal from sparks produced. | Properties of metals, |
| To true and dress a wheel. | Definition of "true" and "dress". Types of wheel dressers. Method of replacing "Burrs". Identification of a "loaded" wheel. Identificaiton of a "Glazed" wheel. | |

BLOCK: Surface Grinder Work

| <u>OBJECTIVE</u> | <u>TECHNICAL INFORMATION</u> | <u>GENERAL INFORMATION</u> |
|--|--|--|
| To adjust table stop settings and table feeds. | Location and purpose of table stops. | Types of surface grinders: <ul style="list-style-type: none">- Hydraulic- Vertical- Rotary |
| To mount a grinding wheel. | Purpose of wheel blotter and recessed flange plate. | Theory of magnetism. |
| To set a cut by means of graduated collars. | Location of feed wheels and power feed handles. Lead per rotation of feed screws. | Knowledge of grinding wheel bonds. |
| To true grind a magnetic chuck. | Wheel types, shapes, sizes, grains, bonds. Standard wheel designations. | Mono-chromatic light wave measurement theory. |
| To true grind a magnetic chuck face. | Method of wheel face grinding. | Theory of the function of angles |
| To set a magnetic chuck at an angle or compound angle by the sine bar application. | Dimensions of gauge blocks in a standard gauge block set. Method of selecting and stacking gauge blocks. Calculation of a sine. | Specific heat of metals. Co-efficient of expansion for various metals. |
| To set up work on: <ul style="list-style-type: none">- Magnetic parallel- Angle plate | Methods of setting up by means of: <ul style="list-style-type: none">- Gauge blocks- Surface Plate- Sine Bar- Indicator- Height Gauge- "V"-blocks | |
| To mount work between centres. | Method of operating an index plate. | |

BLOCK: Surface Grinder Work

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|------------------------------|--|---------------------|
| To grind a flat surface. | Wheel selection for various hardnesses of metal. Method of truing a wheel with a diamond dresser. Warping effects of generated heat. | |
| To grind thin sectioned work | Set up methods by: - Wax - Blocking Methods of measuring surface finishes. | |

BLOCK: Surface Grinder

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|---|--|---|
| To grind to a shoulder | Widths and depths of recesses to maintain maximum strength. | Types of coolants available for grinding operations. |
| To grind two surfaces square with each other. | Use of precision angle plate. Method of mounting work on a precision angle plate Method of checking accuracy of square by means of surface plate. Cylindrical square gauge and prussian blue. | |
| To face grind. | Amount of wheel face clearance. | |
| To form grind. | Method of angle dressing a wheel. Method of radii dressing a wheel. Method of tangentially dressing a straight dress to a curved dress. Method of checking with a comparator (Shadow - graph). Compounding angles on a magnetic size chuck. Method of setting an adjustable angle plate by means of a vernier protractor. Method of dressing a wheel with a radius diamond dresser. | Depths of hardness penetration by standard hardening methods. |
| To grind a convex or concave surface, | | Principles and methods of magnification. |
| To grind a dove-tail . | Method of gauging the dimensions of a dovetail. Method of angle dressing a wheel. | |

BLOCK: Surface Grinder

OBJECTIVE

TECHNICAL INFORMATION

GENERAL INFORMATION

To cut off.

Identification of
abrasive cut-off wheels.

To grind a spline or
flutes.

Method of setting up
between centres.
Methods of using an
indexing plate

Standard spline or
flute dimensions.

BLOCK: Internal Grinder

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|--|---|--|
| To adjust and set table traverse stops. | Location, and methods of adjusting table traverse stops. | Principle of hydraulic rams and pistons. |
| To set spindle and table speeds. | Location, and methods of setting and adjusting spindle and table speed devices. | |
| To change a spindle | Methods of mounting, and various sizes and diameters of spindles. | |
| To mount a grinding wheel on a spindle. | Amount of end pressure required to mount a wheel. | |
| To mount work true in a chuck. | Methods of checking the true run of work by means of: - Chalk - Dial Test Indicator - Wig glow Chuck jaw pressure on thin sectioned work pieces. Soft metal packing methods for tapered work. | |
| To mount work true on a face plate. | Mounting methods and devices. Methods of counter-balancing. Methods of packing. Methods of setting up various indicator attachments. | |
| To adjust handstock for grinding internal and external tapers. | Method of reading a vernier Method of obtaining extremely fine adjustments. | |
| To grind a taper. | Methods of gauging a taper. Methods of calculating a taper in: - Inches per foot - Angles | Triangulation computations. |

BLOCK: Internal Grinder

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|--|---|---|
| To externally and internally grind parallel. | Method of adjusting the headstock. Methods of proving parallelism of the headstock. Methods of compensating for spindle deflection. Consistency of micrometer spindle pressure. | |
| To measure an internal dimension of a bore. | Method of using: - Telescope gauge and outside micrometers - Inside micrometers - Plug gauges | Wiring, shrink, and sliding fits. |
| To end-face grind, | Method of dressing a concavity in the <i>erld</i> of a grinding wheel. Precautions to be observed in presenting the end of the wheel to the work. | |
| To grind to a depth. | Method of setting the table traverse stops. Back-dressing a wheel. | |
| To select a grinding wheel. | Identification of the bond, grain, and grade of a wheel. Hardness identification of the metal to be ground. Knowledge of the correct wheel/metal combination. Metal removal limitations. Surface finishes obtained from various wheels. Requirement for dry or wet grinding. Safety precautions appropriate to grinding operations. | Surface finish symbols. Manufacture of abrasives. Sparking method of hardness identification. |

BLOCK: Cylindrical Grinder

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|---------------------------------|---|--|
| To select a grinding wheel. | Types of bonds, grades grains, and shapes of grinding wheels. Identification symbols for grinding wheels. Wheel/Metal to be removed combinations for best metal removal. Surface finish requirements. Requirements for wet or dry grinding. Conditions conducive to loading and glazing. | Methods of manufacturing abrasives. Surface finish symbols. Capabilities of universal grinders. Principles of centre less grinders. |
| To mount a grinding wheel. | Mounting methods. Ideal locking nut side pressures for various types of wheels. Requirement for, and methods of, wheel balancing. | Knowledge of centroids, Radius of gyration, inertia, |
| To set up work between centres | Method of driving the workpiece. Adjustment of dead-centre pressure. | |
| To mount work true in a chuck. | Method of checking the true run of work in a chuck: - Chalk - Dial Test Indicator - Wiggler | |
| To mount work in a steady rest. | Steady-rest bearing pressure. | |
| To mount a follower-rest. | Location of follower with respect to wheel pressure. | |
| To grind parallel. | Method of adjusting table to obtain parallelism. Method of proving table parallelism. | |

BLOCK: Cylindrical Grinder

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|---|---|---------------------|
| To true dress a grinding wheel. | Method of positioning diamond dresser. Ideal table speed for diamond dressing. | |
| To grind a taper | Calculations for rotating table to obtain included angle of taper. Method of calculating taper in: <ul style="list-style-type: none">- Inches per foot- Angles | |
| To grind an abrupt taper greater than can be accommodated by the rotation of the table. | Method of rotating the lower wheel slide to obtain the correct angle. Method of obtaining an abrupt angle by combining the full rotation of the table and dress the remainder of the angle on the wheel. | |
| To grind close to a shoulder. | Method of selecting the wheel and the technique. <ul style="list-style-type: none">- Off-set wheel with cup to accommodate spindle nut.- Rotation of wheel-head to 45° and ressing wheel to a 90° "V". | |
| To grind an eccentric. | Method of calculating the off-set. Method of mounting the off-set centres between centres. | |
| To plunge grind, | Method of setting up the machine for plunge grinding. | |

BLOCK: Cutter Grinder

OBJECTIVE

To select a grinding wheel.

To set up a cutter grinder for sharpening:

- Plain milling cutters
- Spiral milling cutter
- Formed tooth milling cutters
- Side milling cutters
- Angular milling cutters
- End milling cutters
- Gear tooth milling cutters

To locate the tooth rest.

To grind an inserted blade cutter.

To grind a hob.

TECHNICAL INFORMATION

Cutter faces that require grinding.
Shape of wheel that will best meet the requirements.
Bonds, Grains, and Grades of wheels.

Method of calculating the distance of the centre of the grinding wheel above the tooth rest.
Alternatively, the method of calculating the distance of the centre of the grinding wheel below the tooth rest.
Rule to apply with cup wheels.
Rule to apply with straight wheels.
Rake and clearance angles of milling cutters.
Appropriate coolants to be used.

Method for spiral cutter grinding.
Method for non-spiral cutter grinding.

The need for the "master form".
Method of setting up the master form and the hob on an arbor.

GENERAL INFORMATION

The requirements for differences in rakes and clearances on cutting tools.

Rakes for soft, medium, and hard metal cutting tools

Steel alloys used in the manufacture of cutting tools.

BLOCK: Metallurgy

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|--|--|--|
| To refine iron ore into pig iron. | Method of refining iron ore by a blast furnace. Reason for: <ul style="list-style-type: none">- Coke- Lime- Hot Air Blast | Steel Mill Design. Closed Pit Mining. Open Pit Mining. |
| To make cast iron from pig iron. | Cupola method of producing cast iron. | Machinability of steels. |
| To make steel from pig iron. | Method of producing steel by: <ul style="list-style-type: none">- Open Hearth Furnace- Bessemer Furnace | |
| To make high quality and special steels from selected steel scrap. | Method of producing high quality and special steels by electric arc furnace. | |
| To make a casting. | Casting methods by use of sand molds: <ul style="list-style-type: none">- Flask- Drag* Cope- Core- Print- Facing sand- Backing sand- Graphite | Pattern Making: <ul style="list-style-type: none">- Wooden Patterns- Metal Patterns |
| To chill a casting. | Casting will chill due to rapid reduction in temperature. | |
| To make alloy steels | SAE Steel Specifications The purpose of various alloys in steel. | |
| To test the properties of steel. | Method of Tensile Testing, Method of Compression Testing. Method of Fatigue Testing, Method of calculating the properties of steel from the results of test specimens. | Strength of materials |

BLOCK: Metallurgy

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|------------------------------------|---|--|
| To start a furnace | Principles of: <ul style="list-style-type: none">- Electric Furnaces- Gas Furnaces- Coal Furnaces | |
| To harden steels by quenching. | Critical Temperatures for various steels. Knowledge of: <ul style="list-style-type: none">- Decalescence- Recalescence | Chemical compositions of steels: <ul style="list-style-type: none">- Ferrite- Pearlite- Cementite |
| | Quenching mediums for various steels: <ul style="list-style-type: none">- Brine- Oil- Water- Lead Bath- Air | Chemical changes in steels through temperature ranges: <ul style="list-style-type: none">- Austenite- Tropsite- Sorcite- Martensite |
| To check a temperature. | Physical properties of a pyrometer. Interpretation of "shadow heat". | Co-efficient of expansion of metal. Molecular structure and how effected by heat. |
| To harden steel by Pack Hardening. | Types of Carbon producing packs. Length of time required for "heats". Operation of a muffle furnace. | |
| To case harden with cyanide. | Safety precautions to be recognized when using a cyanide pot. | |
| To anneal a work-piece. | Critical temperatures and length of time of "heat". | Theory of metal deflection under extremes of heat and cold. |

BLOCK: Metallurgy

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|---|--|--|
| To normalize a workpiece. | Critical temperatures and length of time of "heat". Reason for normalizing and annealing. | |
| To temper steels | Translation of "heat" colours into temperatures. Critical heat for tempering various types of metal. Methods of stopping a colour run. Quenching mediums: - water - oil Methods of heating: - Furnace - Iron Bath - Latent Heat | Reduction of primary martensite to secondary martensite. Theory and principle of fluxes. Changes to grain structure of steel through heat ranges |
| To harden steel by the nitriding process. | Operation of an ammonia gas muffin furnace. Process can be used on finished surfaces. | Scale produced by oxidation through contact of heated metal with air. |
| To flame harden, | Can be used to harden specific areas. | |
| To test hardness by: - Rockwell - Brinell - Saleroscope - Vickers | Method of reading hardness tester. Method of preparing specimen for hardness testing. Selection of appropriate "brail" for test specimens. Conversion tables. | Principles of the microscope. Knowledge of the "Metcalfe Experiment" |

BLOCK: Forge

OBJECTIVE

To light a forge:
- Air-gas forge
- Coal or Coke Forge
To heat a workpiece to the required temperature.

To forge on an anvil*

To forge in a vise.

To cut-off by means of a forging chisel

To punch and pierce metal.

To hand forge complicated shapes.

To draw.

To forge an angle.

TECHNICAL INFORMATION

Method of regulating air/gas ratio for correct heating temperature.

Colour method of identifying temperature.
Bending and fusion temperature.
Consequences of overheating.

Selection of tongs, fullers, and anvil accessories.
Method of selecting correct fluxes.

Selection of correct chisel for cut-off.

Types of swages.

Identification of:

- The cold sett
- The hot sett
- The gauge
- The hardie
- Drifts
- Swages
- The flat headed smoothing tool
- Punches
- Fullers (pairs)

Heating temperature for ~~drawing~~ bending allowance and how calculated.

GENERAL INFORMATION

Molecular and grain structure of metals,

Definition of work-hardening and how caused.

Strength of materials

BLOCK: Forge

OBJECTIVE

TECHNICAL INFORMATION

GENERAL INFORMATION

To temper.

Translation of colour
into temperature.

Methods of "holding"
a heat run:

Quenching mediums:

- oil
- water
- brine

BLOCK: Soldering, Brazing & Babbitting

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|---|---|---|
| To dean a surface - Mechanically - Chemically | Types of metal cleaning agents. | |
| To heat a soldering copper. | Safety precautions appropriate to the handling of heated elements. Methods of providing heat - Blow torch - Butane torch - Coal or coke fire. | |
| To tin two mating parts. | Types of solders. Types of fluxes. Necessity for flux. Preparation of surfaces. | Composition of various fluxes. Latent heat factor of various metals. |
| To solder | Methods of applying heat with: - Soldering copper - Electrical soldering iron. | Types of blow torches. |
| To Braze - Carbide tips to cutting tools. - Band Saw Blades - Broken castings. | Cleaning agents. Use of borax as a flux. Method of tempering. | |
| To start an oxy-acetylene torch. | Safety precautions appropriate to the use of oxy-acetylene. Oxygen and acetylene pressure adjustments. | Stability of gasses under pressure. |
| To heat for brazing. | Methods of providing the correct intensity of heat. | |
| To prepare a clay dam. | Types and constituency of clays. | |

BLOCK: Soldering, Brazing & Babbitting

| OBJECTIVE | TECHNICAL INFORMATION | GENERAL INFORMATION |
|---|---|--------------------------|
| To make a babbitt bearing: - Internal - External - Split | Methods of aligning shafts or bores. Scraping and turning allowance. | Bearing load of babbitt. |
| To heat and pour babbitt. | Safety precautions appropriate to handling heating elements. | |