Trade of Metal Fabrication		
Module 1:	: Basic Fabrication	
Unit 3: Tools and Equipment		
	Phase 2	

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Document Release History

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Module 1 – Basic Fabrication

Unit 3 – Tools and Equipment

Duration – 4 Hours

Learning Outcome:

By the end of this unit each apprentice will be able to:

• Describe and demonstrate the common hand tools, holding and measuring devices as used by the metal fabricator

Key Learning Points:

Rk	Hand tools, holding devices, measuring equipment, care, storage and maintenance.	
M	Linear metric dimensions.	
Р	Responsibility and security of tools/equipment.	
Sk	Measurement - clamping devices.	
н	Improper use of tools and equipment.	
M	Fractions - proper and improper - mixed numbers.	

Training Resources:

Apprentice tool kit (as listed) Holding devices Measuring equipment P.P.E.

Exercise:

Questions and answers.

Key Learning Points Code:

M = MathsD = DrawingRK = Related Knowledge Sc = ScienceP = Personal SkillsSk = SkillH = Hazards

Graduated Steel Rules

Graduated steel rules are used for measuring lengths to a moderate degree of accuracy.

Measure flat work as follows:

- Steady the work with your left hand;
- Hold rule with your right hand and steady it with your right thumb against the work;
- Place the edge of the rule on the surface so that the face of the rule is at right angles to the work and square across it;
- Sight up the first numbered graduation with one edge. The corner of a rule may wear and introduce error;
- Sight up the nearest graduation in line with the other edge of the work to take the reading.



Figure 1 - Positioning Rule

Standards of Length

Manufacturing Engineers depend mainly on specialists for the supply of measuring instruments and gauging equipment. These instruments when new are extremely reliable and carefully used will give years of service. It is necessary from time to time to have gauging and measuring equipment checked to detect any wear or damage that may have occurred during its use. To enable this checking to be carried out it is necessary to have a standard to refer to. The most common standard in everyday use is the *Slip Gauge*.

Slip gauges are supplied in sets and are produced in one of four grades of accuracy.

- 1. Workshop Grade. For general use in the workshop when measuring or setting.
- 2. Inspection Grade. For use in the inspection of production parts.
- 3. Calibration Grade.
- 4. Reference Grade.

The last two grades are used only for very high classes of work, usually in a Standards Room for the checking of gauges and measuring equipment.

Slip gauges are made from hardened and ground steel, which is finally lapped to a super finish and high degree of accuracy in the order of two ten-thousandths of a millimetre. Because the surfaces of these gauges are so nearly perfect they can be *wrung* together and become as one piece. The slips are wrung together as shown in Figure 2 after being perfectly cleaned with chamois leather. The operation is carried out with each slip as the stack is built up. Similarly they are wrung apart when the stack is broken down.



Figure 2 - Standards of Length

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Standards of length are:

- 1. the *International Metre* which is kept in Paris. This is in the form of a bar of pure platinum-iridium alloy 102 cm long upon which is marked two lines exactly 1 metre apart. The actual distance is taken from the centres of the lines.
- 2. the *Imperial Standard Yard* which is held at the Board of Trade in London. This is a solid bronze bar, 1 inch cross-section, with two solid gold plugs inserted 36 inches apart upon which the yard lines are marked.

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Accuracy

Calipers cannot be used to measure direct, but must be used to transfer a size to or from a measuring instrument, usually a rule or a micrometer. Great care must be exercised to ensure that the same feel is obtained between caliper and component, and caliper and measuring instrument.

Dividers are used to scribe arcs and circles, the dividers points being set to the required radius using a rule.

Trammels are used in the same way but are designed to accommodate larger radii. The essential difference between calipers and dividers is in the shape of the ends of the legs. Whereas the ends of the calipers are rounded to give a smooth feel, the ends of dividers and trammels are pointed to allow one leg to locate accurately at the centre and the other to scribe the arc or circle required.

Dial Gauges are extensively used for checking concentricity and eccentricity. They can also be used to give a direct comparison between an accurately prepared gauge or setting block and a component. The most common type of dial gauge makes use of the rack and pinion principle to transform longitudinal movement of the spindle to a rotary movement of the needle by which the readings are indicated. Various shapes of stylus can be fitted to the spindle and care must be taken to ensure that the stylus does not work loose during operation. An attachment can be fitted for checking internal surfaces. Dial gauges are extremely delicate instruments and should be treated very carefully, avoiding sudden shock to the spindle.







Dividers



Fractions Still Have Their Uses

With the introduction of a metric system the use of vulgar fractions will give way largely to decimal fractions. It will still be necessary however to understand the meaning of vulgar fractions and their manipulation, particularly their conversion to decimal form.

If you cut a brick into two equal parts, each part will be one half of the brick; this may be written " $\frac{1}{2}$ ".

So one half = $\frac{1}{2}$ (This is a fraction.)

Take a sheet of lead and cut it into four equal parts; each part will represent one quarter; this may be written " $\frac{1}{4}$ ".

So one quarter = $\frac{1}{4}$ (This is a fraction.)

Cut a piece of timber into six equal parts; each part is one sixth $\frac{1}{6}$ of the whole. Take five of these parts and you now have five sixths of the whole; this may be written $\frac{5}{6}$. (This is a fraction.)

Notice that in each case the lower part of the fraction indicates the number of parts into which the whole unit is divided; this is called the *denominator*.

Notice also that the upper part of the fraction indicates the number of parts being used; this is called the *numerator*.

Thus	<u>7</u> Numerator	means that the whole unit is divided into 8
	8 Denominator	parts and 7 of them are being used.

The line between the numerator and the denominator is called the bar of the fraction.

Fractions written in this form are called vulgar fractions (as opposed to decimal fractions which we shall meet later).

Types of Vulgar Fraction

If the numerator is smaller than the denominator then the fraction is called a *proper* fraction

E.g. $\frac{3}{4}$ $\frac{5}{6}$ $\frac{11}{12}$ $\frac{15}{16}$ are all proper fractions.

Each is less than 1 and therefore truly a part of a whole one.

Hence the term proper.

If, however, the numerator is greater than the denominator then the fraction is called an *improper* fraction

E.g. $\frac{5}{4}$ $\frac{18}{12}$ $\frac{27}{16}$ are all improper fractions.

Obviously each is greater than 1 so cannot be a part of a whole one. Hence the term improper. In this case we may obtain what is called a mixed number by dividing the denominator into the numerator and writing down the remainder as a proper fraction.

EXAMPLES

$$5/_4 = 1\frac{1}{4}$$
 $18/_{12} = 16/_{12} = 1\frac{1}{2}$

Notice in the second example that the method of cancellation is used to reduce the proper fraction to its lowest terms. Cancellation is the division of both the numerator and the denominator by a common factor, preferably their HCF.

Many simple problems may be solved by the use of fractions, provided the methods are clearly understood.

Adding and Subtracting Fractions

- 1. Collect all whole numbers.
- 2. Reduce all the fractions to a common denominator. This will be the LCM of all denominators.
- 3. Collect the numerators and unite the final fraction to its lowest terms. Follow these stages carefully in the examples shown below.

EXAMPLE 1:

Simplify:
$$4 + 6\frac{1}{8} + 3\frac{2}{3} - 5\frac{1}{4}$$

Expression = $8 \frac{3+16-6}{24}$
= $8 \frac{13}{24}$ Ans

Note: In the second line, 24, being the LCM of 8, 3 and 4, becomes the common denominator. The fractions are converted to $\frac{1}{24}$ ths and a common bar is used for them all.

EXAMPLE 2:

Simplify:
$$5\frac{3}{8} + 2\frac{1}{8} - 3\frac{1}{4}$$

= $4\frac{3+1-2}{8}$
Expression = $4\frac{2}{8}$
= $4\frac{1}{4}$ Ans

EXAMPLE 3:

Simplify:
$$4\frac{3}{5} - 3\frac{1}{15} + 1\frac{7}{10}$$

= $2\frac{18 - 2 + 21}{30}$
Expression = $2\frac{37}{30}$
= $3\frac{7}{30}$ Ans

Note: The numbers must be taken progressively, i.e. dealing with the whole numbers, the 3 is subtracted from the 4 and then the 1 is added to the result, giving 2. It would have been wrong to add the 3 and the 1 together first and then take the result from 4. The same applies to numerators of the fractions.

EXAMPLE 4:

Simplify: $3\frac{4}{9} - 2\frac{2}{3}$ Expression = $1\frac{4-6}{9}$

Since 6 cannot be subtracted from 4 the 1 must be changed to $\frac{1}{9}$ ths and combined with the 4,

$$= \frac{13-6}{9}$$
$$= \frac{7}{9} Ans$$

EXAMPLE 5:

Simplify: $\frac{6}{7} + 17 + \frac{3}{14} - (4 + 6\frac{1}{2})$

Notice the brackets here, which indicate that this section must be simplified first.

$$= \frac{6}{7} + 17 + \frac{3}{14} - 10\frac{1}{2}$$

= $7\frac{12 + 3 - 7}{14}$
Expression
= $7\frac{8}{14}$
= $7\frac{4}{7}$ Ans

Multiplying and Dividing Fractions

When numbers involving fractions are to be multiplied, the following procedure is adopted:

- 1. Change all mixed numbers to improper fractions.
- 2. Perform any cancelling that is possible.
- 3. Multiply all the numerators together to give a new numerator, and all the denominators together to give a new denominator.
- 4. If this new fraction is an improper fraction change it to a mixed number.

EXAMPLE 1:

Simplify:
$$4\frac{1}{3} \times \frac{1}{2} \times 4\frac{1}{5}$$

$$= \frac{13/3 \times 1/2 \times 21/5}{= \frac{13/3 \times 1/2 \times 7/5}{= \frac{91/3}{10}}$$

= 91/10
= 91/10 Ans

EXAMPLE 2:

Find $\frac{4}{5}$ of $18\frac{1}{2}$

Note: The word of means multiply.

$$= \frac{4}{5} \times 18 \frac{1}{2}$$

= $\frac{4}{5} \times \frac{37}{2}$
Expression = $\frac{2}{5} \times \frac{37}{1}$
= $\frac{74}{5}$
= $14\frac{4}{5}$ Ans

When a fraction is divided by another fraction, first bring both to improper fractions, then invert the divisor (the fraction you are dividing by) and multiply.

EXAMPLE 3:

Simplify:
$$6\frac{1}{4} \div 1\frac{1}{2}$$
 (this could have been written $\frac{6\frac{1}{4}}{1\frac{1}{2}}$)

$$= \frac{25}{4} \div \frac{3}{2}$$

$$= \frac{25}{4} \times \frac{2}{3}$$
Expression = $\frac{25}{2} \times \frac{1}{3}$

$$= \frac{25}{6}$$

$$= 4\frac{1}{6}$$
 Ans

No doubt you will agree that this is very easy to understand, but do not be tempted to hurry these problems. Set out each stage carefully and neatly to obtain the best results.

Self Assessment

Questions on Background Notes – Module 1.Unit 3

1. Give one duty of Employer and one of the Employee in relation to Manual Handling.

- 2. In relation to the structure of the spine
 - **a.** What are Vertebrae?
 - **b.** What sits between Vertebrae?

3. Why is stooping over to lift regarded as harmful?

4. Give two points to ensure when handling a load?

5. When performing Team Lifts choose one important element that you would deem necessary.

6. When lowering an object from a high place (shoulder height or above) give two points to ensure a safe lift.

7. Within the principles of lifting, list three of them.

Answers to Questions 1-7. Module 1.Unit 3

1.



2.

- **a.** Vertebrae are a series of bones that make up the spinal column.
- **b.** Discs sit between vertebrae.

3.

Because it creates uneven pressure on the discs.

4.

- 1. A good secure grip.
- 2. Proper co-ordination of team lifts.

5.

- **a.** To move smoothly and in unison.
- **b.** Choose one person to call the signals.

6.

a. Grasp the object firmly, sliding it down your body.

b. Use a mechanical aid or get help if necessary.

7.

- 1. Think before doing anything.
- 2. Bend your knees and keep your back in a natural line.
- **3.** Hold the load close to the centre of your body.

Bibliography

Video:

Powered Hand Tools Safety

Vocam

Circle Organisation Ltd. Moira House, Trinity Street, Dublin 2, Ireland. www.vocam.com

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