PIE Tech

POLLACHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

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Department of Mechanical Engineering

Regulation 2021

III Year – V Semester

CME396 PROCESS PLANNING & COST ESTIMATION

SYLLABUS

CME396	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
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UNIT I	INTRODUCTION TO PROCESS PLANNING	**09**
Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection		
UNIT II	PROCESS PLANNING ACTIVITIES	**09**
Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies		
UNIT III	INTRODUCTION TO COST ESTIMATION	**09**
Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost		
UNIT IV	PRODUCTION COST ESTIMATION	**09**
Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop		
UNIT V	MACHINING TIME CALCULATION	**09**
Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.		
	TOTAL: 45 HOURS	

UNIT - I

Introduction.

Fixtures:

A Fixture may be defined as a workholding device which only holds and positions the w/p. It does not guide the cutting tool.

Functions:

- To locate and position the w/p relative to cutting tool
- to clamp the w/p during machining, welding, inspection or assembly.

Purpose of Jigs and Fixtures

- To reduce the setting time
- Reduce cycle time
- Semi skilled operator
- Reduce cost of inspection.

Elements of Jigs and Fixtures.

- Clamping elements
- Locating elements
- Tool guiding elements
- tool setting elements.

Factors to be considered Jigs & fixture design

- location
- Clamping
- Loading
- Rigidity
- Clearance of chips
- Fool proof design

- Provision for Tool guides
- Provision for Indexing
- weight
- Safety
- Coolant supply
- Economy.

Types of Jigs:

1. Drill jigs
2. Boring jigs.

Drill jigs

- Drilling, Reaming, Tapping, Chamfering, Spot facing, Counter sinking etc.

Types of drill jigs

- Template jig
- Plate type
- open type
- Swinging leaf
- Box type
- Solid type
- Pot type
- Index jig
- Multistation
- Universal.

Types of Fixtures.

Based on operation:

- Turning Fixture
- Milling Fixture
- Grinding
- Broaching
- boring, drilling
- Tapping
- Fixture for welding
- Assembly

Based on construction

- Plate
- Angle plate
- Vice-jaw
- Indexing

Standard parts for jigs and Fixtures

- Mechanical fastners
- locating and supporting devices
- Indexing pins
- drill bushes
- hand knobs and handles.

Quality Assurance Methods.

- Identification of Inspection locations
- Inspection and testing methods
- Determination of frequency of inspection and Testing
- Evaluation of Inspection
- Corrective action.

Quality :

Juran : Quality is fitness for use

Crosby : Quality is Conformance to requirements.

ISO : Quality is totality of features and characteristics of a product or service that bear on its ability to satisfy stated and implied needs to the customer.

Basic Principles/ Concepts of TQM

- Top management Commitment
- Focus on the customer
- Utilisation of work force
- Continuous improvement
- Treating suppliers as partners
- Establishing performance measure.

TQM Frame work _ (Elements of TQM)

TQM Elements.

TQM Principles and Practices

A. People and Relation Ship

1. Leader Ship
   - Quality council
   - Quality Statements
   - Strategic planning
2. Customer focus
   - customer complaints
   - Customer retention
3. employee involvement
   - Empowerment
   - Team and team work
   - Recognition and reward
   - Performance appraisal.
4. Supplier partnership
   - Sourcing
   - Selection

B. Approach
- Juran Trilogy

1. Continuous Improvement
   - PDSA cycle
   - Kaizen.
   - 5S
2. Innovation, Management by fact

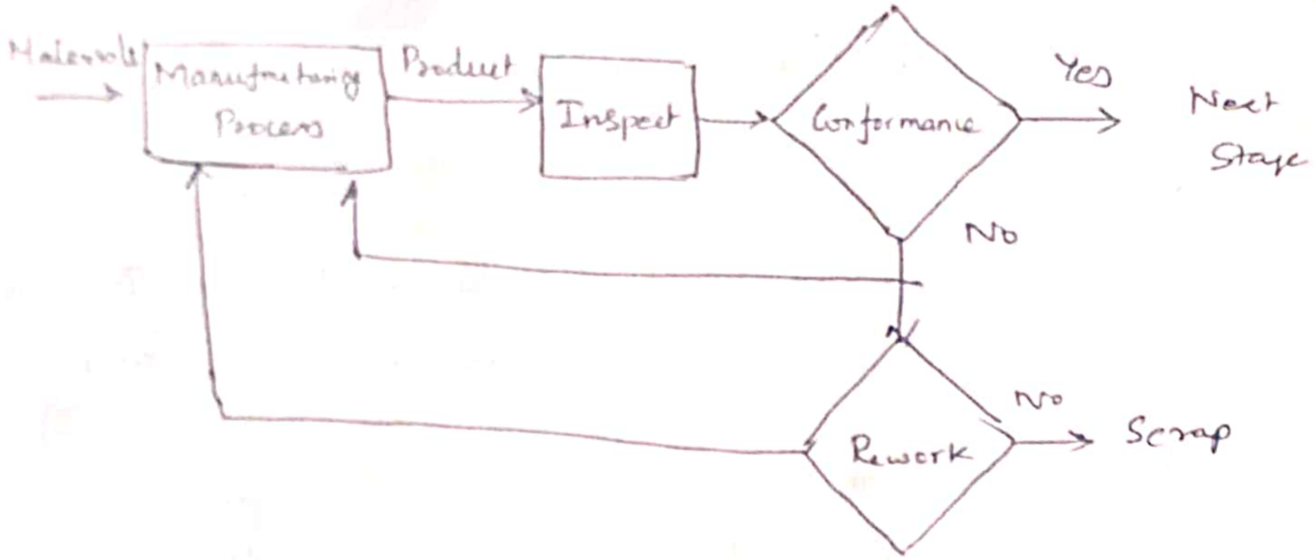
C. Performance measure
- Quality cost
- Quality awards.

TQM Tools and Techniques

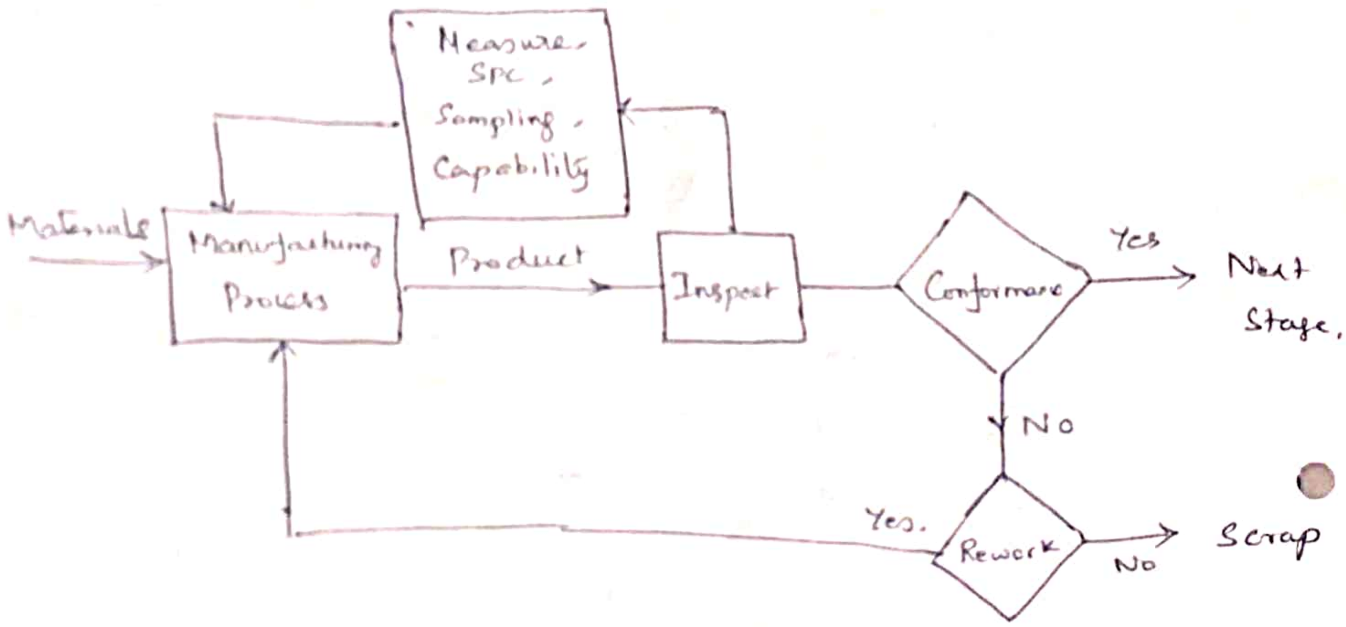
1. Seven tools of Quality
   - Flow chart
   - Check Sheet
   - Histogram
   - Pareto diagram
   - Cause and effect diagram
   - Scatter diagram
   - Control chart
2. New 7 management Tools
   - Affinity diagram
   - Relation Ship diagram
   - Tree diagram
   - Matrix "
   - Matrix data analysing
   - decision tree
   - Arrow diagram
3. Six sigma process
4. Benchmarking
5. FMEA
6. Quality circle
7. Quality Function deployment (QFD)
8. Total Preventive Maintenance
9. Taguchi method
10. Sampling plan
11. Experimental design
12. QMS - ISO 9000
13. EMS - ISO 14000

Basic Quality Strategies

1. Detection Strategy



2. Prevention Strategy



7-Tools of Quality: (7 QC Tools)

1. Flow chart - For depicting the essential steps of a process by using standard symbols.

2. Check Sheet - For systematic data gathering by tabulating the frequency of ~~occurence~~ occurrence.

3. Histogram - For graphically displaying the frequency distribution of the numerical data.

4. Pareto diagram - For identifying the vital few causes that account for a dominant share of quality loss.

5. Cause and effect diagram - For identifying and analysing the potential causes of a given problem.

6. Scatter diagram - For depicting the relationship between two variables.

7. Control chart - For identifying process variations and signalling corrective action to be taken.

Statistical Quality Control:

Statistical Quality control is about employing inspection methodologies derived from statistical sampling theory to ensure conformance to requirements.

- Statistical Process Control (SPC)
- Acceptance Sampling

Control Charts:

A Control chart is a graph that displays data taken over time and the variations of this data.

Types of Control Charts

- For variables
- Attributes.

Types of variable Control Chart

- $\bar{x}$ or average charts
- R or Range charts
- S or Standard deviation charts.

Types of Attributes Control charts

- P-chart
- np chart
- c-chart
- u-chart

Process Capability:

Process capability may be defined as the minimum Spread of a Specific measurement variation which will include 99.7% of the measurements from the given process

Process Capability $= 6\sigma$ (99.7%)

Process Capability Index (Cp)

$$Cp = \frac{\text{Total Specification tolarance}}{\text{Process capability}}$$

$$Cp = \frac{USL - LSL}{6\sigma}$$

Process Capability Index (Cpk)

$$C_{pk} = \min\left\{ \frac{USL - Mean}{3\sigma}, \frac{Mean - LSL}{3\sigma} \right\}$$

Inspection and measurement:

Stages:

1. Incoming Inspection
2. Production process
3. Finished goods.

Methods:

1. 100% Inspection.
2. Sampling Inspection.

Types of Inspection:

- Inspection of variables
- Inspection of attributes

Selecting

Measurement Instrument

- Dimention / Size
- Physical properties
- Function
- Appearance.

Measuring Instrument for variables

Length – Scale, micrometers, Vernier callipers.

Angles – Sine bar, bevel protractor

Straightness – Auto collimeter

Flatness – Interferometer.

Types of limit gauges for Attributes:

1. Plug gauges
2. Ring gauges
3. Taper gauges
4. Snap gauges.
5. Thread gauges
6. Form gauges
7. Fellar gauges
8. Plate & wire gauges.

Selecting measuring Instruments (Factors)

1. Accuracy
2. Linearity
3. Magnification
4. Repeatability
5. Resolution
6. Sensitivity
7. Stability

Documents Required for process planning

(Information Required for process planning)

1. assembly and components drawings
2. Specification of various machine tools.
3. Machining data book
4. Catalogues of various cutting tools
5. Standard materials
6. Charts of limits, Fits, tolerances.
7. Tables of tolerance.
8. Tables of Standard time of operation.
9. Tables of machine hr cost
10. Standard of Standard cost
11. Tables of allowances
12. Process plan for certain Components
13. Hand books (Design data, Tool engineers hand book)

Economics of Process Planning:

Break - Even analysis:

- Cost - Volume - profit analysis.

It is the Study of inter - relation ship among a firm's, sales, costs and operating profit at various levels of output.

Aim: or Objectives:

- deciding profit level
- Compute cost, revenues
- decision regarding make or buy
- Decide the product mix
- plant expansion decisions
- Equipment replacement decisions
- margin of Safety
- price fixing

Break Even point:

The Break even point may be defined as the level of Sales at which total revenues and total costs are equal. It is a point at which the profit is zero.

no profit, no loss point

Determine

Determination of Break Even Point

1. The algebric method
2. The graphical method

Algebric method:

i) BEP at of Physical units

FC - Fixed cost
VC - Variable cost /unit
TVC - Total variable cost
TC - Total cost
TR - Total Revenue (or) Total income
Q - Sales volume (Quantity)
Sp - Selling price per unit.

Total cost = Fixed cost + Variable cost

$$TC = FC + (VC \times Q)$$

Total revenue = Selling price /unit × Quantity

at BEP,

Total cost = Total Revenue

$$TC = TR$$

$$FC + (VC \times Q) = SP \times Q$$

$$Q_{BEP} = \frac{FC}{SP - VC}$$

$$\text{Break Even Quantity} = \frac{\text{Fixed cost}}{\text{Selling price/unit} - \text{Variable cost/unit}}$$

Break even point in terms of Sales Value

$$\text{Break even Sales} = \frac{\text{Fixed cost}}{1 - \frac{\text{Variable cost / unit}}{\text{Selling price / unit}}}$$

$$= \frac{FC}{1 - \frac{VC}{SP}}$$

Contribution :

The difference between selling price and variable cost per unit is known as Contribution or Contribution margin.

$$\text{Contribution} = \text{Selling price} - \text{Variable cost}$$

$$C = SP - VC$$

Contribution ratio

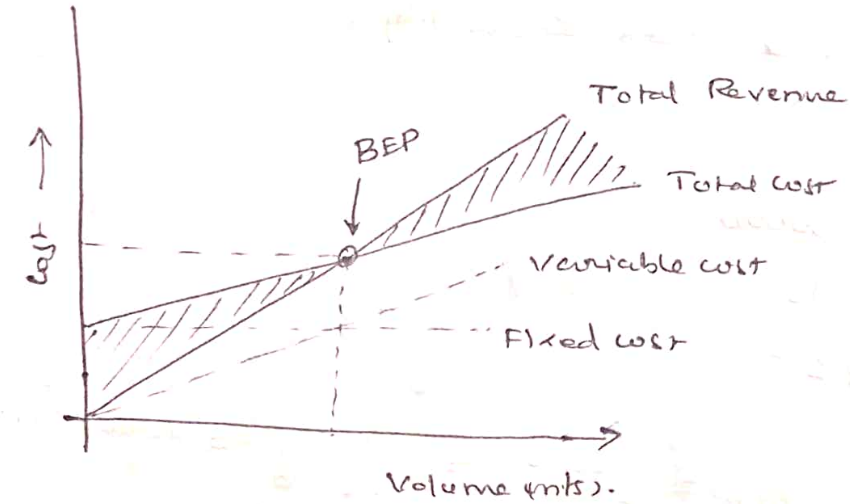
$$\text{Contribution ratio} = \frac{\text{Contribution}}{\text{Selling price}}$$

$$= \frac{\text{Selling price} - \text{Variable cost}}{\text{Selling price}}$$

P/V Ratio : (Profit -Volume ratio)

$$\text{P/V Ratio} = \frac{\text{Contribution}}{\text{Sales}}$$

The Graphical Method:



The point at which the revenue line intersects the total cost line is the break even point.

Margin of Safety

Margin of Safety is the difference between the existing level of output and the level of output at BEP

$$\text{Margin of safety (in \%)} = \frac{\text{Sales} - \text{Sales at BEP}}{\text{Sales}}$$

Eg:

The Fixed costs for a factory for the year 2009-10 are Rs 1,50,000 and the variable cost is Rs 10 per unit produced. The Selling price per unit is Rs 25 Calculate Break even Quantity.

Given:

FC = Rs 1,50000

VC = Rs 10

SP = Rs 25

$$Q_{BEP} = \frac{FC}{SP-VC} = \frac{150000}{25-10} = 10000 \text{ units.}$$

Eg: From the following data, calculate break even point expressed in terms of units and also the new Break even point, if selling price is reduced by 10%.

Fixed Expenses:

Depreciation - Rs 1,25,000

Salaries - Rs 1,00,000

Variable expenses

Materials - Rs 4 per unit

Labour - Rs 2 per unit

Selling price - Rs 15 per unit.

Solution:

$$BEP = \frac{FC}{SP-VC}$$

Fc = Depreciation + Salary

$= 1,25,000 + 1,00,000$

$= \underline{2,25,000}$

Vc = Material cost + labour cost

$= 4 + 2$

$= 6$

$$BEP = \frac{Fc}{SP - VC} = \frac{225000}{15 - 6} = \underline{25,000} \text{ units.}$$

(ii) BEP when selling price reduced by 10%

$$\text{Selling price} = 15 - \frac{10}{100} \times 15 = \underline{13.50}$$

$$BEP = \frac{Fc}{SP - VC} = \frac{225000}{13.5 - 6} = \underline{30,000} \text{ units.}$$

Eg: Following are the information on two machines.

S.No	Item	Capstan lathe	Automatic lathe.
1	Tooling cost	Rs 300	Rs 300
2.	Cost of Cams	-	Rs 1500
3.	Material cost / piece	Rs 2.50	Rs 2.50
4.	operation labour cost	Rs 20 / hr	Rs 80 / hr
5.	cycle time / piece	5 min	1 min
6.	Setting up labour cost	Rs 20 / hr	Rs 20 / hr
7.	Setting up time	1 hr	8 hr
8.	Machine over heads (setting & operation)	300% of (4)	1000% of 4

Find The break even quantity for a job which can be produced on either of The machines. Also comment about the choice of machine based on break - even quantity.

For Capston lathe:

$TC = FC + VC \times Q.$

$FC = \text{Tooling cost} + \text{Setting up cost}$

$$\text{Setting up Cost} = \text{Setting up time} \times \left[\text{Setting up Labour cost/hr} + \text{Machine overheads/hr}\right]$$

$$= 1\ hr \times \left[Rs\ 20 + \frac{300}{100} \times Rs\ 20\right]$$

$$= 1\ hr \times [Rs\ 20 + Rs\ 60]$$

$$= Rs\ 80$$

$$FC = Rs\ 300 + Rs\ 80$$

$$= Rs.\ 380$$

$$\text{Variable cost/piece} = \text{Material cost/piece} + \text{Labour Cost/piece} + \text{overheads/piece}$$

$$\text{Labour cost piece} = \left[\text{Operating Labour cost/hr} \times \text{Cycle time in hr/piece}\right]$$

$$= 20 \times 5/60$$

$$= Rs\ 1.67$$

$$\text{over heads/piece} = \text{Overhead cost/hr} \times \text{Cycle time in hr/piece.}$$

$$= 60 \times 5/60$$

$$= Rs\ 5$$

$VC/piece = Rs\ 2.50 + Rs\ 1.67 + Rs\ 5$

$= Rs\ 9.17$

$\text{Total cost} = FC + VC \times Q$ — (1).

$$\boxed{TC_L = 380 + 9.17\,Q}$$

For automatic lathe. $TC = FC + VC \times Q$

$FC = \text{Tool cost} + \text{Setting up cost} + \text{cam cost}$

$\text{Setting up cost} = \left[\begin{matrix}\text{Setting up} \\ \text{Labour cost/hr}\end{matrix} + \begin{matrix}\text{Machine} \\ \text{over heads/hr}\end{matrix}\right] \times \text{Setting up time}$

$= 8\text{ hr}\ [20/\text{hr} + 80/\text{hr}]$

$= Rs\ 800$

$FC = Rs\ 300 + Rs\ 800 + Rs\ 1500$

$= Rs\ 2600$

$Vc/piece = \begin{matrix}\text{Material} \\ \text{cost/} \\ \text{piece}\end{matrix} + \begin{matrix}\text{Labour} \\ \text{cost/piece}\end{matrix} + \text{Over heads}$

$= Rs\ 2.50 + \left[80 \times 1/60\right] + \left[80 \times 1/60\right]$

$= Rs\ 2.50 + Rs\ \cancel{0.133}\ 1.33 + Rs\ 1.33$

$= \cancel{Rs\ 3.96}\ .\ 5.16$

$TC = FC + (VC \times Q)$

$TC_A = 2600 + \cancel{3.96}\ 5.16\,Q$ — (2)

To find BEP

$$TC_C = TC_A$$

$$380 + 9.17\, Q_{BEP} = 2600 + \overset{5.16}{\cancel{3.96}}\, Q_{BEP}$$

$$2600 - 380 = 9.17\, Q_{BEP} - \overset{5.16}{\cancel{3.96}}\, Q_{BEP}$$

$$2220 = Q_{BEP}(9.17 - 5.16)$$

$$Q_{BEP} = \underline{\underline{\cancel{4206}}}$$

$$= \underline{\underline{553.6}}$$

Result:

Batch size less than 554 units – for Capston lathe

Batch size greater than 554 units – Automatic lathe.

Process Planning activities

Process planning activities.

- drawing interpretation
- Material evaluation and process selection
- Selection of machines and tooling
- Setting process parameters
- Selection ~~Setting~~ of work holding devices
- Selection of quality assurance and inspection
- methods
- cost estimating
- Documenting

Process parameter calculation

Process parameters

- Cutting speed mm/s
- Feed rate (mm/sec)
- Depth of cut mm

Cutting Speed:
It can be defined as the relative speed betn the tool and work piece.

Factors affecting the selection of cutting speed

- Nature of cut (boring - drilling - shaping - hobbing)
- Work material (type, strength)
- Cutting tool material
- Cutting Fluid application
- Purpose of machining
- Kind of machining operation
- Capacity of the machine tool
- Condition of the machine tool

Eg:

Material	Operation (metre/min)					
	Turning	Drilling	Reaming	Shaping	Milling	Grinding
Aluminium	300	120	120	25	200-300	20
Brass	45-75	50	25	12-15	40	22
CI	20	15	10	10	50	12
Copper	30	50	15	10	40	[illegible]
Mild Steel	30	25	12	20	20	15

Cutting speed ranges

SNO	Workpiece material	Cutting speed (m/min)	
		HSS	Carbide
1.	Low carbon steels	20-110	60-230
2	Medium carbon steels	20-80	45-210
3.	Steel alloys	20-80	60-170
4.	Grey cast Iron	20-50	60-210
5.	Stainless steels	20-50	55-200
6.	Chromium Nickel	15-60	60-140
7.	Aluminium	30-110	60-210
8.	Aluminium alloys	60-370	60-910
9.	Brass	50-110	90-305
10.	Plastics	30-150	50-230

<u>Calculation of cutting speed:</u>

For, Turning, boring, milling, drilling

$$S = \frac{\pi D N}{1000} \text{ m/min}$$

S - Cutting speed m/min

D - Diameter of work piece (Turning, boring) - mm

— Dia of ~~workpiece~~ cutter (drilling, milling)

N - Revolution of w/p or cutter in rpm

For Shaping, Planning and Slotting

$$S = \frac{L \times N_s}{1000\, C} \text{ m/min}$$

S - Cutting Speed m/min

L - Length of cutting

N_c - Number of Cutting Strokes/min

C - Cutting time ratio

$$= \frac{\text{Time for Cutting i (forward) Stroke}}{\text{time for return Stroke.}}$$

Problems:

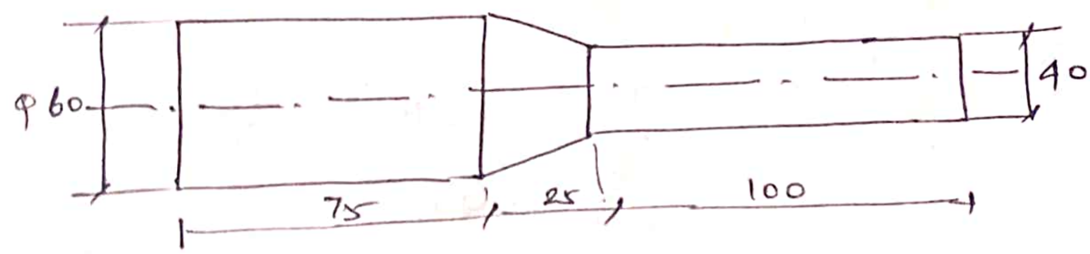
A mild Steel Component Shown in Fig 2.1, has to be made from a stock of 220 mm long and calculate the maximum Cutting Speeds for

(i) Facing operation

(ii) Turning operation of all Surfaces

(iii) Parting off operation

The maximum Spindle Speed of the lathe is 500 rpm



Facing operation:

$$S = \frac{\pi D N}{1000}$$

where D = 40 mm

N = 500

~~do~~ $D = \frac{d_1 + d_2}{2}$

$= \frac{40+0}{2} = 20$

$$= \frac{\pi \times 20 \times 500}{1000}$$

$= 31.42$ mm/min

Turning operation : $\phi 60$

$$S = \frac{\pi D N}{1000}$$

$N = 500$

$D = \frac{60+60}{2} = 60$

$$= \frac{\pi \times 60 \times 500}{1000}$$

$$= 94.25 \text{ mm/min}$$

Taper Turning operation

$$S = \frac{\pi D N}{1000}$$

$N = 500$

$D = \frac{60+40}{2} = 50$

$$= \frac{\pi \times 50 \times 500}{1000}$$

$$= 78.54 \text{ mm/min}$$

Turning operation at $\phi 40$

$$S = \frac{\pi D N}{1000}$$

$D = 40$

$N = 500$

$$= \frac{\pi \times 40 \times 500}{1000}$$

$$= 62.83 \text{ mm/min}$$

Parting off operation.

$$S = \frac{\pi D N}{1000}$$

$D = \frac{60+0}{2} = 30$

$N = 500$

$$= \frac{\pi \times 30 \times 500}{1000}$$

$$= 41.12 \text{ mm/min}$$

Calculation of Spindle Speeds / No of Strokes.

cutting speed

$$N = \frac{1000\,S}{\pi D} \quad \text{rpm}$$

N - Revolution of the work piece / tool or cutter

S - Cutting Speed m/min

D - diameter of work piece.

cutting Speed for Shaping (~~Stro~~ Stroke Speed)

$$N_s = \frac{1000\,S\,C}{L}$$

N_s - Stroke Speed can No of Strokes per min

S - cutting speed in m/min

C - Cutting ratio

$$C = \frac{\text{Time for cutting Stroke}}{\text{Time for return Stroke}}$$

L - Length of cutting.

Problems:

Determine the Spindle Speed required to turn a 60mm diameter Stainless Steel Shaft using a HSS tool (i) What will be the Spindle Speed if a Carbide tool is used instead of HSS tool (ii) Also find resulting percentage increase in the Spindle Speed.

Sol Speed ~~Speed~~ HSS tool

$$N = \frac{1000\,S}{\pi D}$$

S = 20 m/min

D = 60 mm

S = 50 m/s

$$= \frac{1000 \times 20}{\pi \times 60}$$

$$= 106.15 \text{ rpm}$$

265.25 rpm

pindle Speed Carbide tool

4 - ⑦

$$S = 125 \ m/min$$

55 - 9.10
1m
53.57 rpm

$$N = \frac{1000 S}{\pi D}$$

$$= \frac{1000 \times 125}{\pi \times 60} = 663.15 \ rpm$$

$$\% \ increase = \frac{663.15}{106.15} \times 100$$

$$= \underline{624.73} \ \%$$

Feed and Feed Rate :

Feed :

It is the distance through which the tool advances into the workpiece during one revolution of the workpiece or the cutter.

Feed Rate :

It is the speed at which the cutting tool penetrates the work piece.

Unit :

Feed is usually expressed in millimeters per spindle revolution (mm/rev) or mm/min.

Factors affecting feed rate :

(i) Work material (type, strength, hardness)

(ii) Capacity of the m/c tool

(iii) Cutting tool

(iv) Cutting fluid application

(v) Surface finish desired

(vi) Type of operation

(vii) Nature of cut

Feed rates for Turning and Boring.

S.no	w/p material	Feed rate (mm/rev) HSS	Carbides
1	Low carbon steels	0.15-0.45	0.15-1.1
2	Medium-carbon steels	0.15-0.4	0.15-0.8
3	Steel alloys	0.1-0.3	0.1-0.75
4	Grey cast iron	0.1-0.4	0.1-1.0
5	Stainless steels	0.2-0.75	0.2-2.0
6	chromium nickel	0.1-0.6	0.1-1.0
7	Aluminium	0.2-0.6	0.2-1
8	Brass	0.15-0.8	0.15-1.5
9	Plastics	0.1-0.35	0.2-1.0

Feed rate for Drilling.

S.no	Drill dia	drilling feed rate mm/rev HSS	carbides.
1	2	0.05	0.15
2	4	0.10	0.15
3	6	0.12	0.15
4	8	0.15	0.18
5	10	0.18	0.25
6	12	0.21	0.25
7	14	0.24	0.28
8	16	0.26	0.32
9	18	0.28	0.32
10	20	0.30	0.32

Depth

Feed rate for milling :

S.No	w/p material	Milling feed rate mm/tooth HSS		Carbides	
		Face mill	End mill	Face mill	End mill
1.	Low carbon steel	0.2-0.5	0.1-0.25	0.1-0.75	0.15-0.40
2.	Medium carbon steel	0.2-0.5	0.1-0.25	0.1-0.75	0.15-0.40
3.	Steel alloys	0.2-0.8	0.15-0.4	0.3-1.12	0.2-0.5
4.	Grey cast iron	0.15-0.65	0.075-0.3	0.15-0.75	0.075-0.4
5.	Stainless steels	0.2-0.6	0.1-0.3	0.3-1.2	0.2-0.5
6.	Chromium Nickel	0.1-0.6	0.1-0.3	0.3-1.2	0.2-0.5
7.	Aluminium	0.25-0.75	0.15-0.4	0.25-1.0	0.1-0.5
8.	Aluminium alloys	0.25-0.75	0.15-0.4	0.25-1.0	0.1-0.5
9.	Brass	0.25-0.5	0.1-0.25	0.25-0.65	0.1-0.4
10.	Plastics	0.2-0.8	0.15-0.4	0.2-1.2	0.1-0.6

Feed Rate For Shaping

Shaping - 0.05 to 0.75 mm/stroke - &

Planing - 0.5 - 3.0 mm/stroke

Feed Rate For grinding

Cross feed - 1.0 to 1.5 mm/pass

depth feed - 1.0 - 1.5 mm/pass.

Depth of Cut:

Depth of cut is The thickness of The layer of material removed in one cut or pass measured in a direction perpendicular to The machined surface.

Depth of cut for Turning:

- general guidelines for turning and boring recommend a depth of cut of 6mm for roughing and 0.4mm for finishing.

Depth of cut for milling:

- The maximum depth of cut for milling is generally considered to be half The cutter diameter.

Depth of cut for drilling.

The maximum depth of cut for drilling is generally considered to be half The feed rate of The tool and minimum considered to 0.3 mm

Depth of cut for Shaping

In general, the recommended depth of cut for Shaping and planning are in the range of 1-4 mm.

Depth of cut for grinding.

The general recommendations for depth of cut for surface and cylindrical grinding are equal to The values for feeds Selected in mm/pass.

Selection of Jigs and Fixtures:

Work holding devices:

1. General work holding devices
   - Vices
   - Clamps
   - Chucks
   - Collects
   - Centres
   - Mandrels
   - Face plates
2. Specialish work holding devices
   - Jigs
   - Fixtures.

Jigs:

A jig may be defined as a work holding device which locates and holds the work piece for a specific operation. It is also provided with tool guiding elements.

Functions:

- To locate and position the w/p
- To clamp the w/p during drilling, reaming or tapping
- To guide the tool.

UNIT - III

INTRODUCTION TO COST ESTIMATION

Cost Estimation:

Cost estimating may be defined as the process of determining the probable cost of the product before the start of its manufacture.

Factors:

1. Design time
2. Amount and cost of material required
3. Production time required
4. Labour charges
5. Cost of machinery, overheads and other expenses
6. Use of previous estimates of similar parts
7. Effect of volume of production
8. Effect of changes in facilities
9. Probable future changes

Objective of Cost estimation

1. To establish selling price
2. Verify Quotations
3. Marketed profitably
4. To take make or buy decision.
5. To determine economical methods
6. prepare production budget
7. Evaluate alternate design
8. Cost reduction.

Types of Estimates

1. Preliminary cost estimate
2. Final cost estimate

Final desi...

classification of cost Estimates based upon design level

1. Concept design phase (cost estimate accuracy ±30%.)
2. Preliminary design phase (±20%)
3. Detailed design phase (±10%)

Conceptual Design phase:

Conceptual cost estimating is defined as the forecast of project costs that is performed before any significant amount of information is available from detailed design.

levels:

1. Factor method
2. Material cost method
3. The Function method

Preliminary design phase:

In this phase all of the materials and dimensions of the product are known.

methods:

(i). Product comparison method
(ii) Database calculations
(iii) Detailed cost functions
(iv) Parametric cost estimating.

Final design phase:

Complete information of the product are known with more accuracy.

methods:

1. Detailed cost function
2. Traditional approach.

Methods of Estimating:

1. Conference method
2. Comparison method
3. Detailed analysis method.

Parametric Estimating

It is an estimating technique that uses a statistical relationship between historical data and other variables to calculate an estimate for activity parameters such as scope, cost, budget, and duration.

Statistical estimating:

Sampling or random sampling is used in general study a measurable variable and from that sample mean tries to predict or estimate the population mean given some assumptions of the probability distribution.

Data Requirement for cost estimating — Sources of Data

1. General design Specifications - Product engg, Sales dept
2. Rate of production, Quantity - Sales dept
3. Assembly or layout drawings - Product engg, Sales dept, Consumer.
4. List of proposed Sub assembly of product - Product engg, Manufacturing engg
5. Detail drawing, bill of material - Product Engg, Sales dept
6. Test and Inspection procedures - Quality control, Product Engg
7. Machine tool / Equipment requirements - Manufacturing Engg, Vendors of mtls.
8. Packaging and Transportation - Sales dept, Shipping dept, product Engg
9. Manufacturing Routings, operation Sheets - Manufacturing Engg, Method engg
10. Detail tool, gauge, m/c, Equipment - Manufacturing Engg, Material Vendors.
11. operation analysis / Work place studies - Methods Engg
12. Standard time data - charts, tables, time studies, technical books.

13. Material release data - Manufacturing Engg, purchase dept

14. Sub contractor cost - Manufacturing Engg, customer, purchase dept

15. Area and building - Manufacturing Engg, plant layout, plant Engineer.

16. Historical records of previous estimates - Manufacturing Engg, cost dept, sales

17. Current cost of items presently in production - Cost dept, treasurer, controller.

The possible estimates:

(1) over estimation

(2) Under estimation

(3) Realistic estimation

Elements of cost estimation (or)

components of Job estimate (or)

Constituents of Estimation

1. Design cost
2. Drafting cost
3. R&D Cost
4. Material cost
5. labour cost
6. Inspection cost
7. Cost of tools, jigs and Fixtures
8. overhead cost

Cost Estimating procedure:

Step 1. study cost estimating procedure

Step 2. Analyse the product

Step 3. Prepare the list of all product, bill of materials

Step 4. To make or buy decisions

Step 5. Estimate the material cost

Step 6. Cost of purchasing part

Step 7. Manufacturing process plan

Step 8. Maching time estimation

Step 9. Determine the labour cost

Step 10. Determine Prime cost

Prime cost = Direct labour Cost + Direct Material Cost + Direct expenses.

Step 11. Estimate factory over heads.

Step 12. Estimate administrative expenses

Step 13. Estimate Selling and distributing expenses

Step 14. Calculating the total cost

Prime cost + Factory overheads + Administrative expenses + Selling & distribution cost

Step 15. decide the profit

Selling price = Total cost + Profit

Step 16. Estimate the time of delivary.

Costing or Cost Accounting :

Definition :

Costing also known as cost accounting, is the determination of an actual cost of a component after additing different expenses incurred in various departments.

Objectives of cost accounting :

1. Cost determination
2. For fixing selling price
3. Cost control
4. Comparision with estimate
5. Make or buy decisions
6. Wastage reduction
7. To suggest changes in design
8. Profit and loss
9. Fixing the discount
10. Pricing policy
11. Budget prepartion
12. For preparing quotations
13. output targets
14. legal provisions
15. Purchasing new machines / plants.

Metnode of costing

1. Job costing
2. Batch costing
3. Process costing
4. Departmental costing
5. operating cost method
6. Unit cost method
7. Multiple cost method

classification of cost

1. Classification of cost according to elements
   - Material cost
   - Labour cost
   - over heads

2. classification of cost according to function
   - Production cost
   - Administrative cost
   - Selling cost
   - over head cost

3. Classification of cost according to variability
   - Fixed cost
   - variable cost
   - Semi variable cost

4. classification of cost into direct and indirect cost
   - Direct cost
   - Indirect cost

5. Classification of cost according to capital and revenue

- Capital cost
- Revenue cost

Elements of cost :

Total cost

- Materials cost
  - Direct materials cost
  - Indirect material cost
- labour cost
  - Direct labour cost
  - Indirect labour cost
- Expenses
  - Direct expensens
  - Indirect expenses.

Analysis of overhead expenses

(a) Factory expenses

(b) Administrative expenses

(c) Selling expenses

d) Distribution expenses.

Components of cost :

1. Prime cost

$$\text{prime cost} = \text{Direct labour cost} + \text{Direct Material cost} + \text{Direct expenses.}$$

2 Factory or works cost

Factory cost = Prime cost + Factory expenses

3. Production or Manufacturing or office cost

Manufacturing cost = Factory cost + Administrative expenses

4. Total cost

Total cost = Manufacturing Cost + Selling expenses + Distribution expenses

5. Selling price

Selling price = Total cost + profit

6. Market price

Market price = Selling price + Discount.

Estimation of material cost:

Step 1. Study the given drawings. Then break up the product into simple geometrical shapes such as cubes, prisons, cylinders

Step 2. Calculate the volume.

3. Add

4. Cal

Step

3. Add volumes

Step 4. Calculate the wt of the material

wt = volume x density

Step 5. Calculate the material cost

Material cost = wt of the material x cost per unit wt

Densities of materials:

Sl. No	Material	density in gm/cc
1	Aluminium	2.685
2	Brass	8.45
3	Bronze	8.735
4	Cast iron	7.2
5.	Copper	8.96
6.	Gold	19.316
7.	Lead Sheet	11.34
8.	Mild steel	7.868
9.	Nickel cast	8.285
10.	Teak wood	0.657-0.882
11.	Tin	7.420
12.	Wrought iron	7.707
13.	Zinc	6.87

Estimation of labour cost:

(i) Setup time
(ii) Operation time
 - handling time
 - machining time
(iii) Tear down time
(iv) Miscellaneous allowances
 - Personal allowance
 - Fatigue
 - Contingency
 - Process
 - Interference
 - Special.

Allowances in cost estimation:

Allowance is an amount of time added to the normal time to provide for personal delays, unavoidable delays and fatigue of the operator.

Types of allowances:

1. Relaxation allowances
 - Personal need allowances
 - Fatigue allowances
2. Contingency allowance
3. Process allowances
4. Interference allowances
5. Special allowances.

Standard t

Standard time :

It is defined as the total time in which a job should be completed at standard performance

Standard time = Normal time + allowances

Normal time : (Basic time)

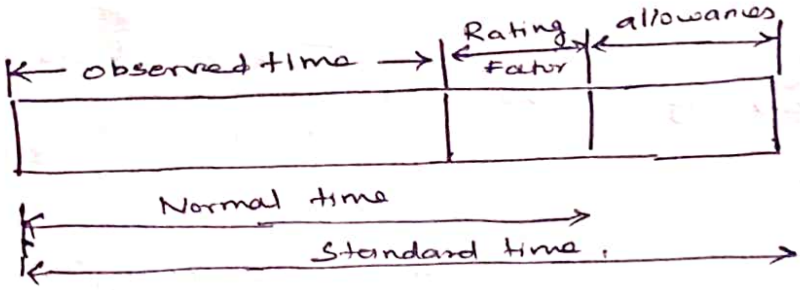
It is the time for carrying out a work at standard rating

Normal time = observed time × Rating factor

Rating factor :

It is a levelling factor to convert observed timings into normal timings

$$\text{Rating factor} = \frac{\text{observed time}}{\text{Normal time}} \times 100$$



Allocation of overhead expenses!

Methods of allocation of over heads expenses.

1. By percentage (allocation by cost proportion)
   - Percentage on prime cost
   - Percentage on direct labour cost
   - Percentage on direct material cost

2. By hourly rate (allocation by hourly rate)
   - Man hour rate
   - Machine hour rate
   - Combination of man hour and machine hr rate

3. By unit rate (allocation by unit rate)
   - unit rate method.

Formulas used!

$$\text{Percentage of overheads} = \frac{\text{Total overhead cost}}{\text{Total direct labour cost}} \times 100$$

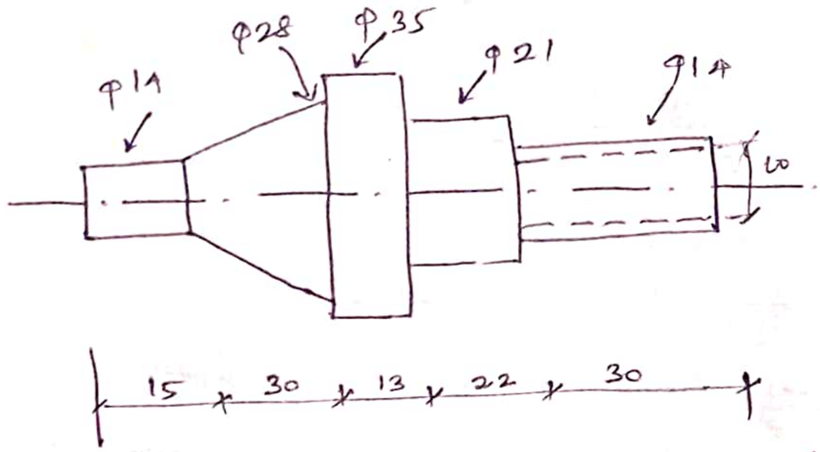
$$= \frac{\text{Total over head cost}}{\text{Total direct material cost}} \times 100$$

$$= \frac{\text{Total overhead cost}}{\text{Total production man-hours spent}}$$

$$= \frac{\text{Total over head cost}}{\text{Total productive m/c hrs.}}$$

Eg-1

Estimate the weight of material required for manufacturing 220 pieces of shaft as shown in fig. The shafts are made of mild steel which weighs 7.87 gm/cc and cost Rs100/kg. Also calculate the material cost for 220 such shafts.



7.86×10^{-6} kg/mm³

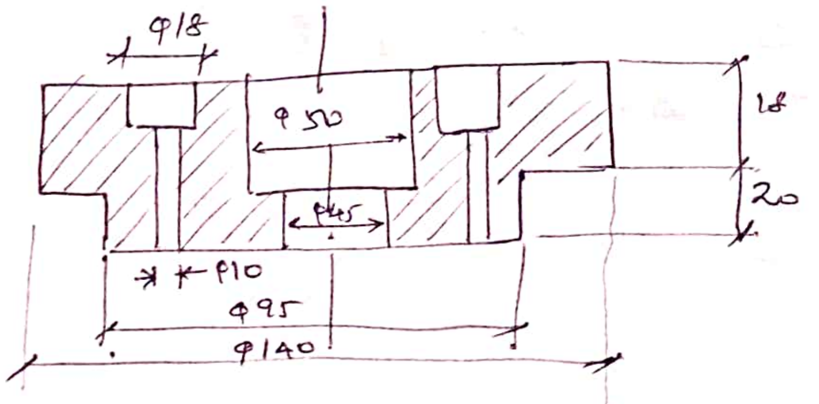
All are in mm

1 piece wt : 0.2803 kg
220 pc wt : 61.72 kg

cost = 6172 Rs.

Eg 2:

Find the cost of the material for the machine part shown in fig. density of the material may be taken as 8.2 gm/cu cm. The cost of the material is Rs 30/kg. The cost of material of the finished component. Assume 20% wastage of material and 6 holes for bolt



piece wt : 3.94 kg

cost = 118.20 Rs.

Depreciation:

The Reduction in the value and efficiency of the plant, equipment or any fixed asset because of wear and tear, due to passage of time, use and climatic conditions is known as depreciation.

Causes of depreciation:

depreciation.

Due to physical conditions

1. Wear and tear
2. Physical decay
3. Accident
4. Poor maintenance

Due to functional conditions

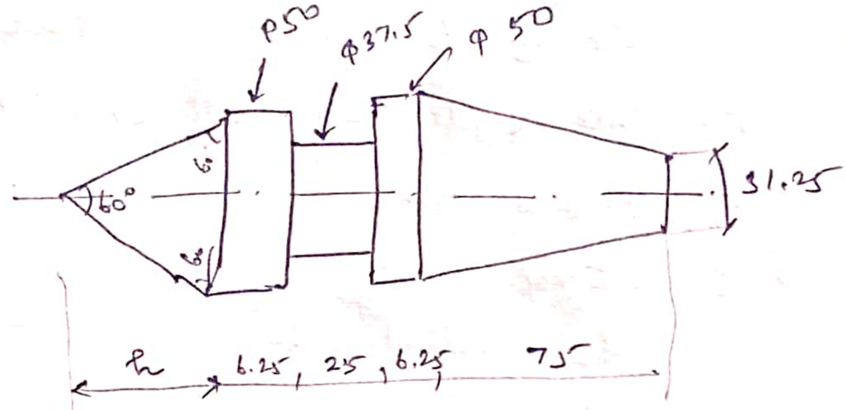
1. Inadequacy.

Methods of depreciation.

1. Straught line method
2. Reducing balance method
3. Sinking fund method
4. Annuity method
5. Sum of year's digits method
6. Insurance policy method
7. Production unit method
8. Revaluation method
9. Machine hr method
10. Retirement method.

Q: 3

Fig shows lathe centre, Estimate the wt and cost of material for the same if the material weighs 7.787 gm/cc and the material cost is Rs 100/kg.



Ans: 1.397 kg, Rs 139.70

1) Straight line method

$$D = \frac{C - S}{n}$$

C - Initial cost of the machine

S - Scrap (or Salvage) value

n - Estimated life of the m/c

D - Depreciation amount per year.

2) Diminishing Balance (Reducing Balance) method

$$p = 1 - \left(\frac{S}{C}\right)^{1/n}$$

C - Initial cost of the m/c

S - Scrap value

p - Fixed percentage for calculating yearly depreciation

n - Estimated life of the m/c

Sinking Fund method

$$D = \frac{(C-S)r}{(1+r)^n - 1}$$

D - Rate of depreciation per year

r - Rate of Interest on depreciated fund in %.

C - Initial Cost

S - Scrap value

n - Estimated life

Annual Method:

$$D = \frac{[C(1+r)^n - S][1-(1+r)]}{[1-(1+r)^n]}$$

Machine hour method:

$$\text{Depreciation rate per hr} = \frac{C-S}{\text{Total machine hours over useful life of machine.}}$$

Production unit method:

$$\text{Depreciation Cost per unit} = \frac{C-S}{\text{Number of units it is expected to produce.}}$$

UNIT-IV

Production Cost Estimation

Estimation in Forging shop

Forging :

It is defined as the process in which the desired shape and size of an object is obtained through the plastic deformation of the metal of the object.

Types of Forging

1. hot forging
   - Connecting rod, crank shaft, cam shaft etc
2. Cold forging
   - Bolt heads, nails, rivets etc

Forging process

1. Hand forging
2. Drop forging
3. Press forging
4. Machine forging

Forging operations

1. Upsetting
2. Drawing Down
3. Setting Down
4. Bending
5. Punching
6. Drifting
7. Swaging

Estimation of material losses in Forging

1. Shear loss
2. Tonghold loss
3. Scale loss
4. Flash loss
5. Sprue loss.

Estimation of Forging cost

(i) Material cost
(ii) Labour cost
(iii) over head cost

$$\text{Total forging cost} = \text{Labour cost} + \text{Material cost} + \text{overhead cost}$$

Calculation of material cost :

Step 1. $$\text{Net weight} = \text{Volume of forging} \times \text{density of material}$$

Step 2. To calculate gross wt

$$\text{Gross wt} = \text{Net wt} + \text{Material loss}$$

Step 3. To find material cost

$$\text{Material cost} = \text{Gross wt} \times \text{Price of raw material cost}$$

Step 4. To select the diameter and length of Stock

$$\text{length of Stock} = \frac{\text{Gross wt}}{\text{Density of material} \times \text{Cross sectional area of Stock}}$$

Calculation of labour cost :

Labour cost = Forging time per piece in hrs × Labour rate per hr in Rupees

Estimation for Forging time:

Time required for heating the job

Job	M.S or W.I	Medium C Steel	High C Steel	Tool or HSS
upto 100gm	50 sec	up 1min	upto 1min	upto 1.5 min
100 - 200 gm	90 sec	1 - 1.5	1 - 2	1.5 - 2.5
200 - 400 gm	2.5min	1.5 - 3	2 - 3	2 - 3.5
400 - 800 gm	3 - 3.5	3 - 4	3 - 4	3 - 4.5

Time Required for performing operations:

Job Volume in cc	MS or WI	Medium C Steel	High C Steel	Tool or HSS
upto 2	upto 20 sec	upto 25 sec	upto 30sec	upto 32 sec
2 - 4	20 - 30	26 - 35	35 - 40	35 - 40
4 - 8	40 - 50	35 - 50	45 - 60	45 - 50
8 - 16	1 - 1.5	1 - 2	1 - 2.5	1 - 2.5
16 - 32	3 - 6	3.5 - 6	4 - 7	3 - 7

Estimat

Q 1.

A bar stock of 3 cm dia. and 2m long is to be converted into (i) square bar 3 cm side (ii) hexagonal bar 3cm side and (iii) Rectangular bar of sides 3cm x 2cm. Calculate the length of bar made in each case.

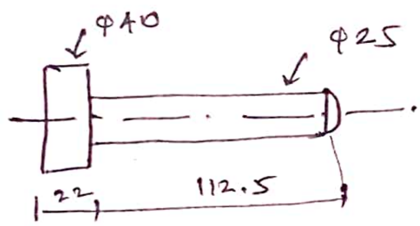
Ans

(i) Square bar length => 157.08

(ii) hexagonal => 60.46

(iii) Rectangular => 235.62

Q 2. 200 pieces of bolt are to be made by upsetting from 25mm dia. What is the length of each bolt before upsetting? What length of the rod is required if 3.5% of the length goes to scrap.



Estimation in Welding Shop

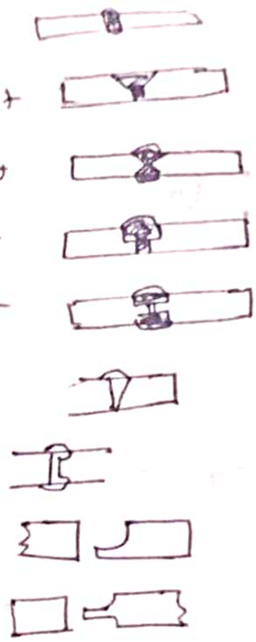
Welding is the process of joining similar or dissimilar metals by the application of heat.

Types of welding:

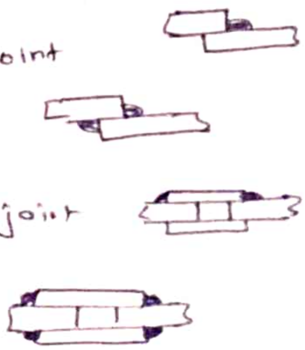
1. Plastic or pressure welding
2. Fusion or Non-pressure welding

Types of weld joints

1. Butt joint
   - Straight butt joint
   - Single Vee butt joint
   - Double Vee butt joint
   - Single U butt joint
   - Double U butt joint
   - Single Bevel
   - Double Bevel
   - Single J butt
   - Double J bull



2. Lap joint
   - Single fillet lab joint
   - Double fillet lab
   - Single strap lab joint
   - Double strap



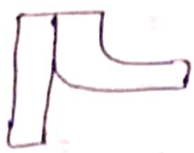
T. Joint

- Single fillet T joint 
- Double fillet 

Corner joint :

- 
- 

Edge joint



Edge joint

Flange joint

Estimation of welding cost

Total welding cost ⇒

- Direct material cost
- Direct labour cost
- Direct expenses
- overhead expenses

Estimation of Gas welding cost

Gas welding:

Gas welding is the process of joining two metal pieces by a gas flame obtained by the combustion of fuel gas and oxygen

Estimation of oxy-acetylene welding

Direct material cost = Cost of base material + Cost of filler rod, O_2, C_2H_2 gases

Direct labour cost = Preparation ~~of~~ pre-welding labour cost + Welding cost + Post welding cost

Direct expenses = Cost of welding fixtures and other expenses

over head expenses.

~~Estimation~~

Gas cutting:

Gas cutting or flame cutting is a process of cutting metals into pieces using oxy-acetylene flame.

Estimation of Electric arc welding cost

Electric arc welding:

It is defined as the process of joining two metal parts by melting their edges by an electric arc using filler rod without application of pressure.

1. Direct material cost = Cost of Base materials + Cost of electrodes

2. Direct labour cost = Preparation (or) pre welding labour cost + Welding cost + Finishing cost

3. Cost of power

4. over head expenses.

$$\text{power cost} = \frac{VA}{1000} \times \frac{t}{60} \times \frac{1}{\eta} \times \frac{1}{r} \times c$$

V - Voltage in volts

A - Current in amps

t - Welding time in min

η - Efficiency of the welding m/c

- 0.6 for welding transformer
- 0.25 for welding generator

r - Ratio of operating time

c - Ratio of electricity per kwhr in Rs

Estimation in Foundry Shop

Foundry:

Foundry is the process of casting metals into objects of specified shapes.

Casting:

The molten metals or alloys are poured in the moulds and allowed to cool. The object after cooling is known as casting.

Mould:

The mould is a cavity or a matrix formed in a heat resistant material usually sand.

Estimation of pattern cost:

Pattern:

A pattern is a replica of the object to be made by the casting process

Pattern materials

- Wood, Aluminium, brass
- Plaster of paris, plastics.

Pattern allowances:

- Shrinkage allowances
- Draft allowances
- Machining allowances
- Distortion allowances
- Shake allowances.

Estimation of pattern cost

Total pattern cost = Direct material cost + Direct labour cost + overheads

Direct material cost = Gross wt of the pattern material including pattern allowances * Cost per unit wt

Direct labour cost = Estimated time to manufacture the pattern * labour rate

Estimation of Foundary cost.

Total cost of a cast component = Total material cost + labour cost + Direct expenses + Overhead expenses

Ex: Forging

150 pieces of stepped shaft are to be drop forged from raw stock of 20mm dia. Estimate cost assuming the following.

(i) Shaft size : Step on left 10mm dia x75 mm long

Step in the middle : 20mm dia x125 mm long

Step on right : 10mm dia x 75mm long

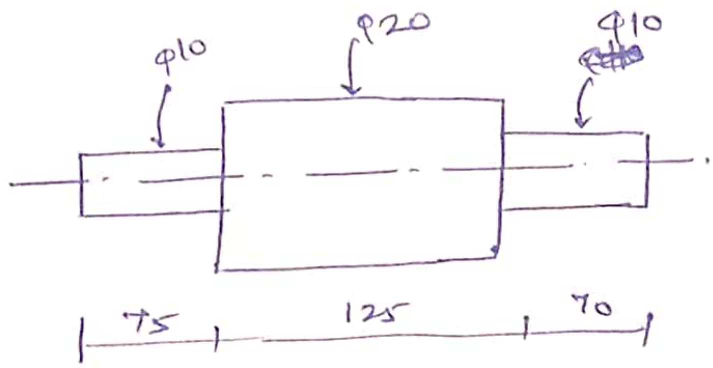
(2) Material cost Rs 200/meter

(3) cost of forging Rs 1200 per Sq metre

(4) over heads 100% of forging cost

3 Ex:

150 pieces of shaft as shown in Fig. are to be drop forged from the raw stock of 2cm dia. Estimate the cost incurred assuming that material cost Rs 300 per metre. cost of forging = Rs 1000 per Sq meter of surface area to be forged. over head expenses to be 100% of the cost of the forging consider all losses.



UNIT-V

Machining Time Calculation:

Machining time:

It is the time for which the machine works on the component i.e from the time when the tool touches the work to when the tool leaves the component after completion of operation.

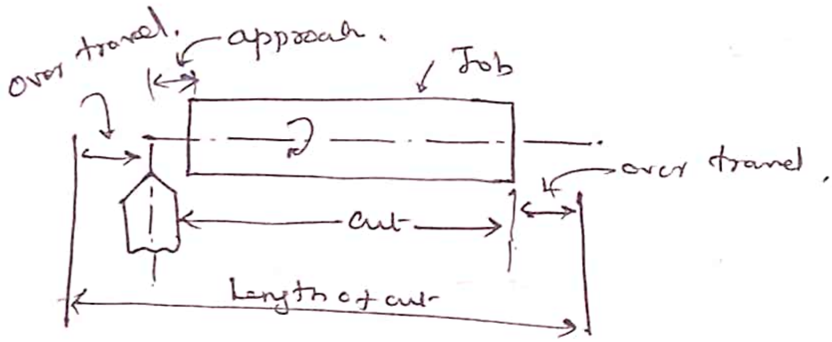
Terms used in Machining time:

1. Length of cut

Length of cut is the distance travelled by the tool to machine the workpiece.

Q.

$$\text{Length of cut} = \text{Approach Length} + \text{Length of w/p to be machined} + \text{over travel.}$$



Approach length:

It is the distance a tool travels from the time it touches the work piece until it is cutting to full depth.

Over travel:

It is the distance over which the tool idles before it enters and after leaves the cut

2. Feed:

Feed is the distance, through which the tool advances into the work piece during revolution of the w/p or the cutter.

Depth of cut:

Depth of cut is the thickness of the layer of metal removed in one cut or pass, measured in a direction perpendicular to the machined surface.

Cutting Speed:

The cutting speed can be defined as the relative speed between the tool and the wo

$$\text{cutting Speed} = S = \frac{\pi D N}{1000} \text{ m/min}$$

$$N = \frac{1000 S}{\pi D} \text{ rpm}$$

Calculation of machining time for lathe operations:

Turning operation:

Turning is the process of removing the excess material from the workpiece by means of a single pointed cutting tool.

T - Turning Time in min

f - Feed per revolution in mm

L - length of the job mm

N - Revolutions of the job / min in rpm

$$\Rightarrow \frac{1000S}{\pi D}$$

S - cutting Speed in meters / min

D - Diameter of the job

$$\text{Time taken} = \frac{L}{\text{Feed/min}}$$

$$\boxed{T = \frac{L}{f \times N}}$$

Considering No of cuts.

$$T = \frac{L}{fN} \times \text{No of cuttings required.}$$

Considering over travel approach.

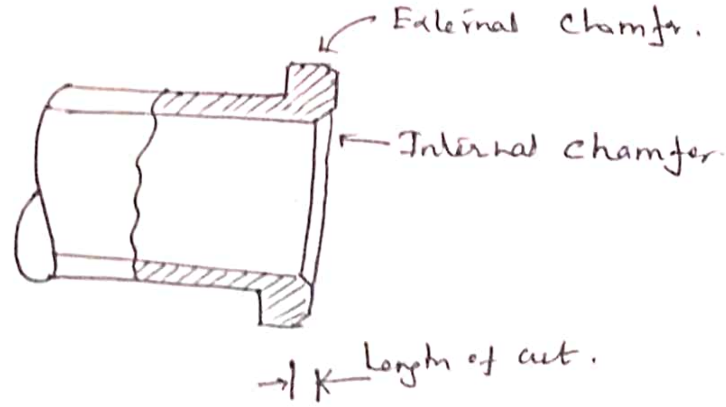
$$T = \frac{A + L + O}{f \times N} \times \text{No of cuts required}$$

O - over travel in mm

A - approach length in mm

Chamfering:

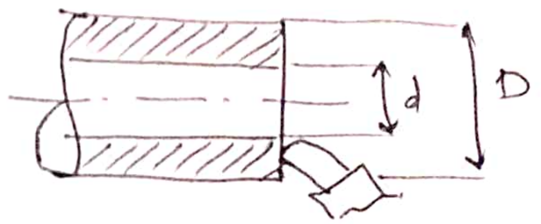
Chamfering is the operation of removing material from the edges of external or internal diameter



Time for Chamfering $T = \dfrac{L}{f \times N}$

Facing:

Facing is the process of removing material from the ends of the job by moving the tool perpendicular to the axis of the job



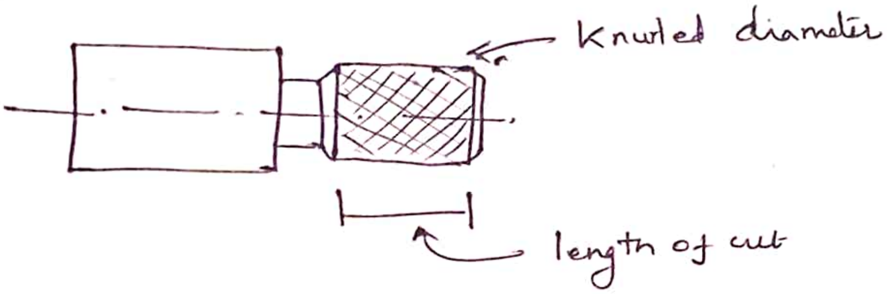
$$\text{Time for facing} = \frac{L}{f \times N}$$

L = length of job on cut

$= \frac{1}{2} \times$ diameter of job (solid)

$= \frac{1}{2}(D-d)$ for hollow job

Knurling :



Knurling is the operation of upsetting material so as to produce diamond shaped or straight lined patterns on the surface of the material.

$$\text{Time for knurling } T = \frac{L}{f \times N}$$

Drilling :

Drilling is the process of producing holes in the materials

$$\text{Time for drilling} = \frac{\text{Depth of hole to be produced}}{\text{Feed/rev} \times \text{rpm}} = \frac{L}{f \times N}$$

Boring:

Boring is the operation of enlarging or finishing an internal hole which has been previously drilled.

$$\text{Time for boring} = \frac{L}{f \times N}$$

Reaming:

Reaming is the process of removing a small amount of material from a previously drilled or bored hole for perfecting the hole.

$$\text{Time for Reaming} = \frac{\text{Length of cut}}{\text{feed/rev} \times \text{rpm}}$$

Tapping:

Tapping is the operation of cutting internal threads with the help of a tool called tap.

$$\text{Actual Length of tap} = L + D/2$$

L - Length of tapped portion

D - Diameter of tap used

$$\text{tapping time} = \frac{L + D/2}{\text{Feed/rev} \times \text{rpm}}$$

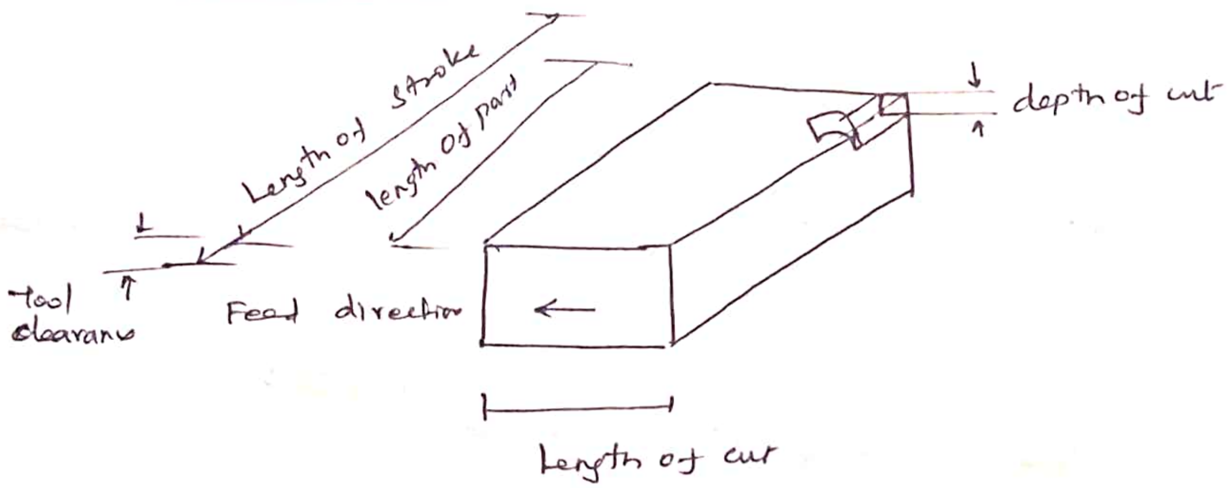
$$= \frac{L + D/2}{\text{Pitch} \times \text{rpm}}$$

Threading:

Threading is the process of removing material to produce helix on external or internal circular surface for fastening ~~pu~~ purpose.

$$T = \frac{\text{Length of cut}}{\text{Pitch} \times \text{rpm}} \times \text{No. of cut}$$

Estimation of machining time for Shaping, planning and slotting operations



Effective cutting Speed (C)

$$C = \frac{L}{1000} \times N \quad \text{m/min}$$

L - Length of forward stroke in mm (Including clearance on each ends)

N - No of forward strokes /min

cutting Speed (S)

$$k = \frac{\text{Time for return Stroke}}{\text{Time for forward stroke}}$$

$$S = \frac{L(1+K)}{1000} \times N \quad m/min$$

Total time for one cut (T)

Time taken by cutting stroke $= \dfrac{L}{S \times 1000}$

Return Stroke $= k \times$ Cutting Stroke time

$$= \frac{L \times k}{S \times 1000}$$

$$T = \frac{L}{S \times 1000} + \frac{Lk}{S \times 1000}$$

$$= \frac{L(1+k)}{S \times 1000}$$

If w = width of the job in mm

f = Feed per stroke

Total Time for completing one cut =

$$= \frac{L(1+k)}{S \times 1000} \times \frac{w}{f}$$

Total time required

p – No of cuts or pass

$$T = \frac{L(1+k)}{S \times 1000} \times \frac{w}{f} \times p$$

Problems:

Eg 1.

A Component can be produced on either capstan lathe or an automatic lathe. The different cost factors for the two machines are given below.

Machine A.

Fixed cost : Rs 500

Variable cost : Rs 2/piece

Machine B

Fixed cost : Rs 1600

Variable cost : Rs 0.5/piece

Assume that cycle time for production of the component is same for both the machines. which machine will you select for producing (a) 800, (b) 700 components.

Sol

To find

Type of machine for producing N_1 and N_2

(a) ~~Let~~

Given data:

$FA =$ Rs 500

$VA =$ Rs 2

$FB =$ Rs 1600

$VA -$ Rs 0.5

Machine I | Machine II

(a) let $N_1 = 800$

Machine I:

Total cost $= F_A \times N_1 V_A$

$= 500 + 800 \times 2$

$= 2100$

Machine II:

Total cost $= F_B + N_1 V_B$

$= 1600 + 800 \times 0.5$

$= 2000$

(b) lett $N_1 = 700$

Machine I:

Total cost $= F_A \times N_2 V_A$

$= 500 + (700 \times 2)$

$= 1900$

Machine II:

Total cost $= F_B + N_2 V_B$

$= 1600 + 700 \times 0.5$

$= 1950$

Result:

$N_1 = 800$ for Machine II

$N_2 = 700$ for Machine I

Eg 2

The following information is available for two machines.

Item	capstan lathe	automatic lathe
1. tooling cost	Rs 300	Rs 300
2. cost of cams	Rs —	Rs 1500
3. Material cost/piece	Rs 2.50	Rs 2.50
4. Operation labour cost	Rs 5/hr	Rs 2/hr
5. Cycle time	5 min	1 min
6. Setting up labour cost	Rs 20/hr	Rs 20/hr
7. setting up time	1 hr	8 hr
8. M/c over heads	300% of (4)	1000% of (4)

Find the Break even Quantity.

Sol

1. Capston lathe :

$$\text{over heads} = \frac{300}{100} \times 5 = Rs\ 15/hr$$

Fixed cost = Tooling cost + Setting up labour cost + setting up over head

$= 300 + 20\times1 + 15\times1$

$= Rs\ 335$

Variable cost/piece = Material cost + Labour cost + operation over heads

$= 2.50 + 5 \times 5/16 + 15 \times 5/60$

$= Rs\ 4.1.6$

2. Automatic lathe

$$\text{over heads} = \frac{1000}{100} \times 2$$

$= Rs\ 20$ per/hr

Fixed cost $= (300 + 1500) + (20\times8) + (20\times8)$

$= 2120$

Variable cost $= 2.50 + (2\times 1/60) + 20 \times 1/60$

$= Rs\ 2.86$

If Q is Break even Quantity

$$F_A + QV_A = F_B + QV_B$$

$$335 + Q\times4.16 = 2120 + Q\times2.86$$

$$Q = \underline{\underline{1373}}\ \text{pieces}$$

Eg 3:

A Semiautomatic turret lathe cost Rs 80,000 and it produces 16 pieces/hr. and its operator receives Rs 2 per hr. An Engine lathe which costs Rs 32,000 produces 10 pieces per hr and in its operator receives Rs 2.50 per hr. Calculate the minimum number of pieces which makes turret lathe more economical.

Given data:

Fixed cost F_A = Rs 80,000

V_A = Rs 2 /hr.

No of pieces produced /hr = 16

Engine lathe

Fixed cost F_B = Rs 32,000

V_B = Rs 2.50 per/hr

To find

Minimum no of pieces which makes turret

Sol

Lathe more economical, Q

Total cost of turret lathe = Total cost of Engine lathe

(Fixed cost + Variable cost) of turret lathe = (Fixed cost + Variable cost) of engine lathe

$$F_A + Q V_A = F_B + Q V_B$$

$$Q = \frac{F_A - F_B}{V_B - V_A} = \frac{80,000 - 32000}{\frac{2.5}{10} - \frac{2}{16}}$$

$$Q = \underline{\underline{384000 \text{ pieces.}}}$$

Ep:

The air craft flap nose rib can be produced either by hydropress or by steel draw die. The following data is available for $N_t = 500$

P_a = Rs 8.40 P_b = Rs 14.80

T_a = Rs 6480.00 T_b = Rs 1616.00

Determine the quantity of production at break even point and tool unit cost for method A and method B.

Given data:

$N_t = 500$

P_a = Rs 840 T_a = Rs 6480

P_b = Rs 14.80 P_b = Rs 1616

To find:

(i) Quantity of production at break even poin &
(ii) Tool unit cost for method A, Ca, Rs and
(iii) Tool unit cost of method B, Cb Rs.

Sol

(i) $$Q = \frac{T_a - T_b}{P_b - P_a}$$

$$= \frac{6840 - 1616}{14.80 - 8.40}$$

$$= 760 \text{ pieces.}$$

(ii) $$C_a = \frac{T_a + P_a \times N_t}{N_t}$$

$$= \frac{6480 + 8.40 \times 500}{500} = \text{Rs } 21.36$$

(iii) $C_b = \dfrac{T_b + P_b \times N_t}{N_t}$

$= \dfrac{1616 + 14.80 \times 500}{500}$

$= 18.03$

Result:

(i) $Q = 760$ pieces

(ii) $C_a =$ Rs 21.36

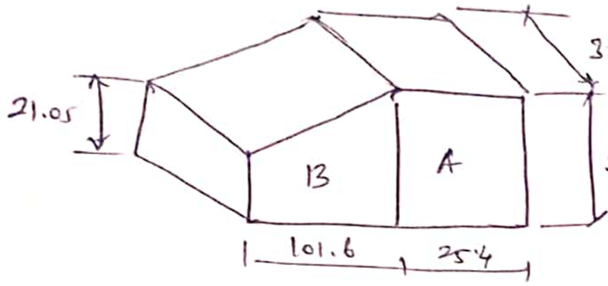
(iii) $C_b =$ Rs 18.03

2

1.

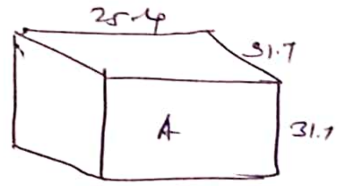
Forging:

Q: The wedge shown in fig. It is made of 38.1 mm diameter stock by forging. calculate the length of the bar if the volume remains unchanged.



Sol

Divide the wedge into components A, B, consider Component A It is Simple rectangle



Surface area

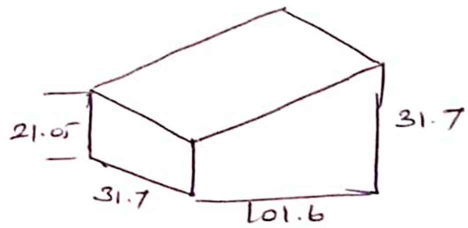
$A_A = l \times b$

Volume $= lbh$

$V_A = 31.7 \times 31.7 \times 25.4$

$= 25,524.206 \ mm^3$

consider component B



$A_B = \frac{1}{2}(a+b)h$

$V_B = A_B \times \text{Thickness}$

$A_B = \frac{1}{2}(21.05 + 31.7)\ 101.6$

$= 2679.7$

$V_B = 2679.7 \times 31.7$

$= 84,946.49$

Total Volume $= V_A + V_B$

$= 25524.206 + 84946.49$

$= 110470.696 \ mm^3$

Now volume of cylindrical bar stock

$$V_1 = \pi/4\, d^2 l$$

$$= \pi/4\,(38.1)^2\, l$$

$$= 1140.091\, l$$

The volume can not change

$$1140.091\, l = 114070.696$$

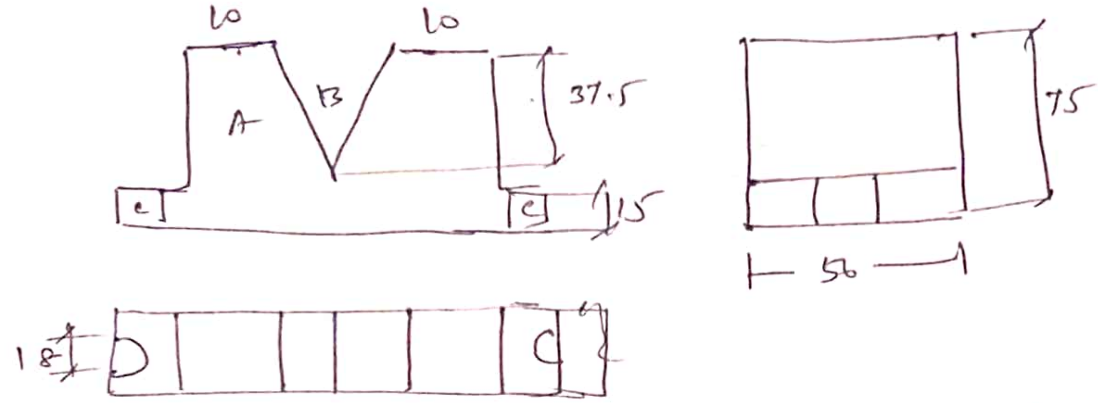
$$l = \frac{114070.696}{1140.091} = 96.9$$

$$\simeq 97\, mm$$

The length of bar stock = 97 mm

Eg:

Three orthographic view of CI V block are shown what would be the weight of the material required for the block if CI weighs : 7.2 gm/cm^3 ?



Sol

The total volume of the V block is calculated as follows

$V = V_A + V_C - V_B - V_D$

$V_A = lgh = 95 \times 56 \times 75$

$= 399000 \text{ mm}^3$

$V_B = \frac{1}{2}(lbh) = \frac{1}{2}(75 \times 37.5 \times 56)$

$= 78,750 \text{ mm}^3$

$V_C = 2(lbh) = 2(38 \times 15 \times 56)$

$= 63840 \text{ mm}^3$

$V_D = 2\left[(bh) + \frac{1}{2}\left(\frac{\pi}{4} d^2 l\right)\right]$

$= 2\left[(15 \times 18 \times 15) + \frac{1}{2}\left(\frac{\pi}{4} 18^2 \times 15\right)\right]$

$= 11917.035 \text{ mm}^3$

$V = V_A + V_C - V_B - V_D$

$= 399000 - 78750 + 63840 - 11917.035$

$= 372171.43 \text{ mm}^3$

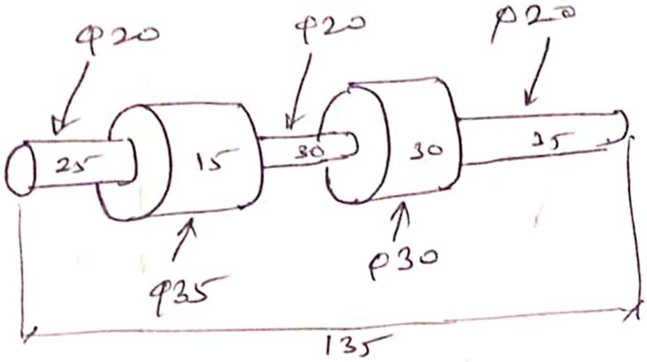
Wt of the block $= 372171.43 \times 7.2$

$= 2679.6$ gm

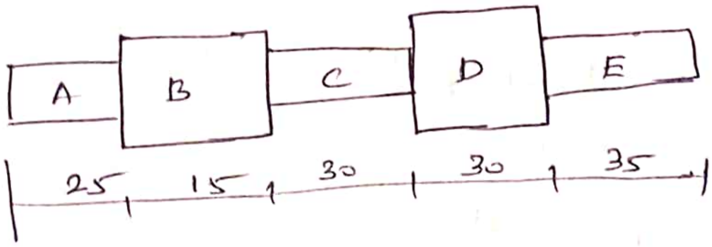
$= \underline{2.68 \text{ kg}}$

Eg:

Estimate the wt of the aluminium shaft, Al weighs 9 gms/cm³. Also calculate the material cost if 1kg Aluminium cos Rs. 8



Sol:



$V_A = \pi/4\, d^2 l = \pi/4 (20)^2 \times 25$

$= 7853\ mm^3$

$V_B = \pi/4\, d^2 l = \pi/4 (35)^2 \times 15$

$= 11431.69\ mm^3$

$V_C = \pi/4\, d^2 l = \pi/4 (20)^2 \times 30$

$= 21205.75\ mm^3$

$V_D = \pi/4\, d^2 l = \pi/4 (30)^2 \times 30$

$= 84780/4 = 21195\ mm^3$

$V_E = \pi/4\, d^2 l = \pi/4 (20)^2 \times 35$

$= 10,995.57\ mm^3$

$V = V_A + V_B + V_C + V_D + V_E$

$= 7853 + 11431 + 21205 + 21195 + 10995$

$= 63911 \text{ mm}^3$

wt of The Shaft $= 63.911 \times 9$

$= 575.205$ g

$= 0.575$ kg

Cost of The material $= 0.575 \times 8$

$= \underline{\underline{\text{Rs } 4.6}}$

Eg:

From the following data, Evaluate the

(i) Total cost

(ii) Selling price for an electric fan

- Material cost = Rs 5000
- Manufacturing wages : Rs 3500
- Over head cost = 100% of mfg wages
- Non mfg over heads = 15%
- Profit 12% of total cost.

Sol

Direct material cost = Rs 5000

Direct labour cost = Rs 3500

Factory over heads = 100% of 3500 ⇒ 3500

Factory cost = Direct mtl cost + Labour + overhead co

= 5000 + 3500 + 3500

= 12,000

Non - mfg over heads = 15% of Factory cost

$= \frac{15}{100} \times 12000 =$ Rs 1800

Total cost determination

Total cost = Factory cost + Non mfg cost

= 12000 + 1800

= 13800

Profit on total cost = 12%

= 12% of Total cost

$= \frac{12}{100} \times 13800$

= 1656

Selling price = Total cost + Profit

= 13800 + 1656

= 15,456

Selling price = Rs. 15,456

From the records of an oil mill, the following data are available

(a) Raw material

opening Stock = Rs 1,40,000

closing Stock = Rs 1,00,000

Total purchase during The year = Rs 2,00,000

(b) Finished goods

Opening Stock = Rs 20,000

closing Stock = Rs 30,000

Sales = Rs 6,00,000

(c) Direct wages = Rs 1,00,000

(d) Factory expenses = Rs 1,00,000

(e) Non Manufacturing expenses : Rs 85,500

Find out What price should be quoted for a product involving an expenditure of Rs 35,000, in material and Rs 45,000 wages. Factory expenses to labour cost is 100%.

Sol

Direct material cost = Opening Stock + Total purchase − Closing Stock

= 1,40,000 + 2,00,000 − 1,00,000

= 2,40,000

Direct wages = 1,00,000

Factory Expenses = 1,00,000

Factory cost = Direct material cost + Direct labour + Factory over heads

= 2,40,000 + 1,00,000 + 1,00,000

= Rs 4,40,000

Non Manufacturing expenses = Rs 85,000

Total cost = Factory cost + Non Mfg Expenses

= 4,40,000 + 85,000

= Rs 525000/-

Factory expenses of direct labour cost = 100%.

Non mfg expenses = $\frac{85000}{4,40,000}$ = 19.31 %

Cost of finished goods = opening stock + cost of goods − closing stock

= 20,000 + 5,25,000 − 30,000

= 5,15,000

Cost of the Fished goods = Rs 5,15,000

Total Sales = Rs 6,00,000

Profit = Rs 6,00,000 − 5,15,000

= 85,000

Profit to sales cost = $\frac{85,000}{515000}$ = 16.5%.

The cost of the product to be quoted is listed

Direct material cost = Rs 35,000

Direct labour cost = Rs 45,000

Factory expenses = 100% of wages

= Rs 45,000

Factory cost = Direct material cost + Labour cost + Factory expenses

= 35000 + 45000 + 45000

= 1,25,000

Administrative and selling expenses = Non mfg expenses

= 19.31 % of Factory cost

= 24,137

Total cost = 1,25,000 + 24137.50

= Rs 1,49,137

Profit = 16.5 % ~~Relation~~ of Total cost

$= \frac{16.5}{100} \times 1,49,137$

= 24,607

Quotation price = 1,49,137 + 24 607

= 1,73,744

Selling price = Total Cost + Profit

= 3410 + 682

= 4092 /-

Cost per unit $= \frac{4092}{\text{No of units}}$

$= \frac{4092}{50}$ = Rs 81.84

List price = Selling price + Discount

= Selling price + 20% list price

list price 'x'

$x = 81.84 + \frac{20}{100} x$

$x = 81.84 + 0.2x$

$0.8x = 81.84$

$x = 81.84 / 0.8$

= 102.30

List price = Rs 102.30

Eg: A factory produces 100 bolts and nuts per hr on a machine. material cost is Rs 375, labour Rs 245 and direct expenses is Rs 80. The factory on cost is 150% and office on cost is 30%. If sales price is Rs 11.30 find whether company incurs profit or loss.

Sol

Material cost = 375.00

Labour = 245.00

Direct expenses = 150% of labour cost

= 245×1.5 = Rs 367.50

Factory cost = 375 + 245 + 80 + 367.5

= Rs 1067.50

office on cost = 30% of factory cost

$= \frac{1067.50 \times 30}{100}$

= Rs 320.25

Total cost = 1067.50 + 320.25

= 13.87 /-

Cost per unit = $\frac{1387.75}{100}$ = 13.87

Sales price = 11.30

Hence, the company incurs a loss of Rs 2.57 /-

4:

A factory has 15 lathes of same make and capacity and 5 shapers of same make and capacity. Lathes occupy $30 m^2$ area, while shapers occupy $15 m^2$. During one calender year, factory expenses for this selection area are as follows.

(i) Building rent and depreciation Rs 5000

(ii) Indirect labour and material Rs 15000

(iii) Insurance Rs 2000

(iv) Depreciation of lathe Rs 5000

(v) Depreciation charges of shapers Rs 3000

(vi) Power consumption fo the lathe Rs 2000

(vii) Power consumption of shaper Rs 1000

Find out m/c hrs rate for lathe, shaper 25000 hrs, 8000 hrs.

Sol

(a) lathe section

Total over heads for the 8 lathe section

(i) Building rent and depreciation

$$= \frac{5000 \times 30}{30+15} = Rs\ 3333.33$$

(ii) Indirect labour and material

$$= \frac{15000 \times 30}{30+15} = Rs\ 10000$$

(iii) Insurance $= \frac{2000 \times 30}{30+15} = Rs\ 1333.33$

(iv) depreciation: Rs 5000

Total overheads = Rs 21666.66

Machine hour rate for a lathe $= \frac{21666.66}{25000}$

$= Rs\ 0.87$

Shaper Section:

(i) Building rent and depreciation

$$= \frac{5000 \times 15}{30+15} = \text{Rs } 1666.66$$

(ii) Indirect labour and material

$$= \frac{15000 \times 15}{30+15} = \text{Rs } 5000$$

(iii) Insurance $= \frac{2000 \times 15}{30+15} = \text{Rs } 666.66$

(iv) Power consumption = Rs 1000.00

(v) depreciation = Rs 3000.00

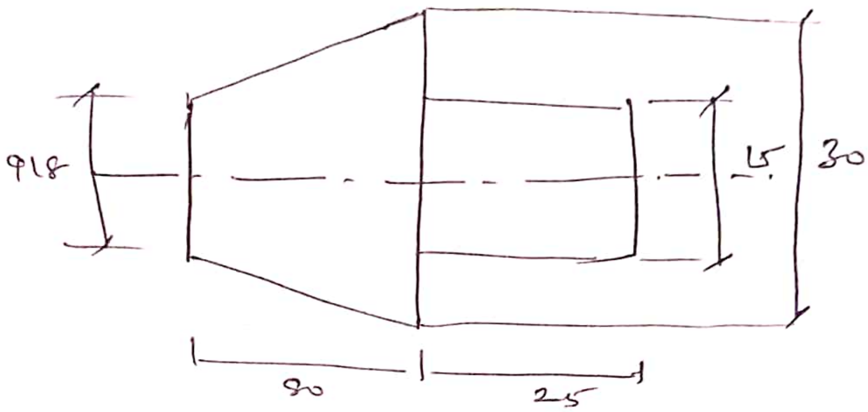
Total overheads = Rs 11332.32

Machine hour rate for Shaper

$$= \frac{11332.32}{8000}$$

$$= 1.42$$

Calculate the time required to turn the component as shown in Fig. Assume cutting speed of 30 m/min hand feed by compound rest 10.5 mm/rev, depth of cut 2.5 mm and feed for turning 0.75 mm/rev



Sol.

(1) Time required to reduce from 30 mm dia to 15 mm dia for 25 min length is calculated as follows

$$\text{Number of cuts} = \frac{30-15}{2 \times 2.5} = 3 \text{ cuts}$$

$$t_1 = (30-25) = \frac{25}{0.75 \times \frac{1000 \times 30}{\pi \times 30}} = 0.1046 \text{ min}$$

$$t_2 = (25-20) = \frac{25}{0.75 \times \frac{1000 \times 30}{\pi \times 25}} = 0.087 \text{ min}$$

$$t_3 = (20-15) = \frac{25}{0.75 \times \frac{1000 \times 30}{\pi \times 25}}$$

$$= 0.0697 \text{ min}$$

(ii) Time required for taper turning

length of cut CD = $\sqrt{ED^2 + EC^2}$

$ED = \frac{30-18}{2} = 6mm$

$EC = 80mm$

$CD = \sqrt{6^2 + 80^2} = 80.22 \text{ mm}$

Avg length of cut $= CD/2 = 40.11 \text{ mm}$

No of cuts required $= \frac{EF}{2.5}$ { one cut 2.5 mm

$\sin\alpha = \frac{EF}{EC} = \frac{ED}{CD}$

$EF = EC \times \frac{ED}{CD} = \frac{80 \times 6}{80.22} = 5.98$

No of cuts $= \frac{EF}{2.5} = \frac{5.98}{2.5} = 3$ cuts

Avg diameter, $D = \frac{18+30}{2} = 24$ min

$$T_m = \frac{L}{f \times \frac{1000 \times v}{\pi D}}$$

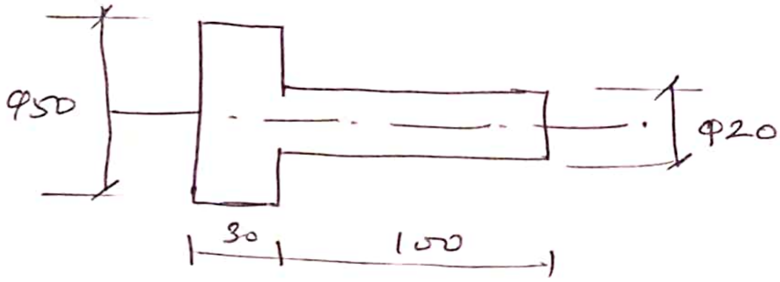
$$= \frac{40.11}{0.5 \times \frac{1000 \times 30}{3.14 \times 24}}$$

$= 0.2$ min.

Total time required for this cuts $= 0.2 \times 3 = 0.6$

$= 0.6$ min

Two hundred component as in fig. are to be made by upsetting a 20 mm diameter bar. Find the net wt, gross wt and length of bar required density of material = 7.88 gm/cc.



Sol/

Total volume of material

$= \text{Head volume} + \text{Shear volume}$

$= \pi/d\,(50)^2 \times 30 + \pi/4\,(20)^2 \times 100$

$= 58.875 + 31400$

$= 90275\ mm^3 = 90.275\ cm^3$

Net wt per unit $= 90.275 \times 7.88$

$= 711.4$ grams

Net wt of 200 units $= 711.4 \times 200$

$= 1,42,280$ gms

$= 142.28$ kg

Considering losses :

Shear losses = 5% of Net wt

$= \frac{5}{100} \times 711.4 = 35.57$ gms

Scale loss $= 6\%$ of Net wt

$= 0.06 \times 711.4$

$= 42.684$ gms

Gross wt for 200 units

$= 711.4 + 35.57 + 42.68$

$= 789.65$ gms

Length of 20mm diameter bar required

$= \text{Density} = \dfrac{\text{Mass}}{\text{Volume}}$

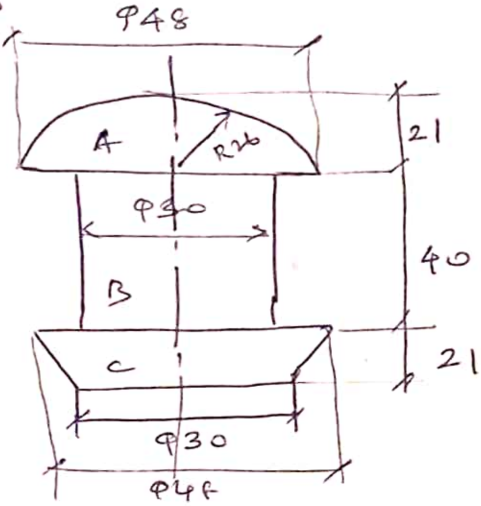
$= \dfrac{\text{Mass}}{\text{Area} \times \text{length}}$

$\text{Length} = \dfrac{\text{Mass}}{\text{Area} \times \text{Density}} = \dfrac{157930}{\frac{\pi}{4}(2)^2 \times 7.86}$

$= 6393.9$ cm

$= 63.93$ meters

Find the number of mild Steel rivets as in fig. can ~~bee~~ be produced from 19 kg of mild steel, assume a scale loss of 10% volume, the density of mild steel is 7.92 g/cm³



Sol

Volume of snap head A $= \frac{\pi}{3} h^3 (3R - h)$

$= \frac{\pi}{3} (2.1)^2 \times (3 \times 2.8 - 2.1)$

$= 29.09\ cm^3$

Volume of stem(B) $= \frac{\pi}{4} d^2 h = \frac{\pi}{4} 3^2 \times 4$

$= 28.27\ cm^3$

Volume of pan head(C) $= \frac{\pi}{12} h (D^2 + d^2 + Dd)$

$= \frac{\pi}{12} \times 2.1 (4.8^2 + 3^2 + 4.8 \times 3)$

$= 25.55\ cm^3$

Total Volume of one rivet

Volume $= 82.91 \times \frac{110}{100} \times 91.2\ cm^3$

wt of material required for one rivet = 91.2×7.92

$= 722.3$ gms $= 0.722$ kg

No of rivets than can be produced from 19 kgs 6 ks

$= \dfrac{19}{0.722}$

$= 26.3$

$\simeq 26$ Nos