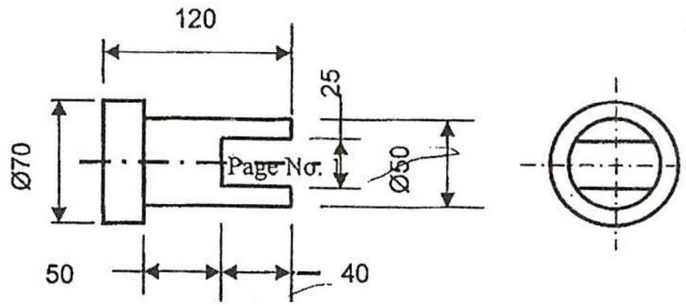
Unit – 4 Production Cost Estimation

Part – A

1. **Estimate the weight of the component shown in fig. the material is CI (AU A/M '18)**



Volume of the component = volume of A + Volume of B – Volume of C

$= (\frac{\pi}{4}d^2l) + (\frac{\pi}{4}d^2l) - (b \times l)$

$= \left(\frac{\pi}{4} \times 70^2 \times 30\right) + \left(\frac{\pi}{4} \times 50^2 \times 90\right) - (50 \times 25)$

= 115454 + 176715 +1250

= 290919 cm^3

Weight of the component = Volume x Density

Assume density of CI = 7.2 g/cc

Weight of the component = 290919 x 7.2

= 2094617 g = 2094.62 kg

2. **What are the causes of depreciation? (AU A/M '18)**

Depreciation due to physical condition
- Wear and tear
- Physical decay
- Accident
- Poor maintenance of equipment

Depreciation due to functional conditions
- Inadequacy
- Obsolescence

3. **Give the formula for calculating the cost of power consumed in arc welding (AU N/D '17)**

Power cost = $\frac{V \times A}{1000} \times \frac{t}{60} \times \frac{1}{\eta} \times \frac{1}{r} \times C$

V = voltage in volts

A = current in amperes

t = welding time in minutes

η = efficiency of the welding machine

r = ratio of operating time to connecting time taken by operator

C = rate of electricity per kWhr in Rs

4. **Define roll forging (AU N/D '17)**

Roll forging is used to draw out sections of bar stock, *i.e.,* reducing the cross-section and increasing the length. Special roll forging machines, with dies of decreasing cross-section are used for roll forging.

5. **List the losses to be considered in estimating the gross weight of a forging component? (AU M/J ’16) (AU N/D ’16) (AU N/D ’14) (AU N/D ’13) (AU A/M ’17)**
   - Scale loss
   - Flash loss
   - Tonghold loss
   - Sprue loss
   - Shear loss
6. **Differentiate leftward and rightward welding. (AU N/D ’16) (AU A/M ’18)**
   Leftward welding: In this method, welding is started from right hand side of the joint and proceeds towards left. This method is used for welding plates upto 5 mm thick. No edge preparation is required in case of the plates of thickness upto 3 mm.
   Rightward welding: This method is adopted for welding thicker plates. Welding proceeds from left to right. The flame is directed towards the deposited metal and rate of cooling is very slow.
7. **Brief about the procedure to calculate material cost. (AU N/D ’15)**
   Direct material cost = Gross weight × Price/kg.
   Gross weight = Net weight + Material loss in the process.
   Net weight = Volume of forging × Density of metal.
8. **How can you calculate the labour cost for a turning process in lathe? (AU N/D ’13)**
   Direct labour cost = $t \times l$
   Where t = Time for truning process per piece (in hrs)
   l = Labour rate per hour
9. **Define Flash loss (AU N/D ’13)**
   There is a certain quantity of metal which comes between the flat surfaces of the two dies after the die cavity has been filled in. This material equal to the area of the flat surface is wastage. For finding the flash loss, the circumference is determined which multiplied by cross-sectional area of flash will give the volume of the flash. The volume multiplied by material density gives the flash loss. Generally, it is taken as 3 mm thick and 2 mm wide all round the circumference.
10. **What are the various elements considered while calculating the cost of a welded joint? (AU N/D ’12)**
    The total cost of welding consists of the following elements :
    - Direct material cost.
    - Direct labour cost.
    - Direct other expenses.
    - Overheads.
11. **State any four pattern allowances. (AU N/D ’12)**
    (i) Shrinkage Allowance
    (ii) Machining Allowance
    (iii) Draft Allowance
    (iv) Distortion Allowance

12. Define production cost (AU A/M ’17)

Prime cost = Direct material cost + Direct labour cost + Direct expenses (if any)

Factory cost = Prime cost + Factory overheads

Cost of production = Factory cost + Administrative overheads + Miscellaneous overheads (if any)

13. What are overhead costs? (AU A/M ’17)

Overhead expenses include all expenditure incurred by the manufacturer on the product except the direct material cost, direct labour cost and direct chargeable expenses.

(a) Indirect material expenses.

(b) Indirect labour expenses.(supervisors, inspectors, foremen, store-keeper, gatekeepers, repair and maintenance staff, crane drivers, sweepers, administrative office staff and sales and distribution staff, etc.)

(c) Other indirect.(water and electricity charges, rent of factory building, licence fee, insurance premia stationery, legal expenses, audit fee etc.

Part – B

1. **Market price of a CNC lathe is Rs. 50,000 and discount is 20% of market price. Here factory cost is 4 times selling cost and 1 : 4 : 2 is ratio of material, labour and overhead charges. Material cost is Rs. 4000. What is profit value?(16 marks) (AU M/J ’16)**

Solution

Material cost	= 4000
From ratio, Labour cost	= 16,000/-
Overheat charges	= 8000/-
Factory cost	= 4000 + 16000 + 8000
	= Rs. 28000/-
Now selling price	= 28000 / 4
Total cost	= 28000 + 7000
	= Rs. 35000/-
Selling price	= Market rate – Discount
Profit	= Selling price – Total cost
	= 40000 – 35000
	= 5000

Company incurs Rs. 5000/- as profit.

2. **Explain the different items involved in the estimation of arc welding cost of job. (6 marks) (AU M/J ’16) (AU N/D ’16)**

Estimation of Cost in Welding

The total cost of welding consists of the following elements:

1. Direct material cost.
2. Direct labour cost.
3. Direct other expenses.
4. Overheads.

1. Direct Material Cost

The direct material cost in a welded component consists of the following :

- Cost of base materials to be welded *i.e.,* sheet, plate, rolled section, casting or forging. This cost is calculated separately.
- Cost of electrodes/filler material used. The electrode consumption can be estimated by using the charts supplied by the suppliers. Another way to find the actual weight of weld metal deposited is to weigh the component before and after the welding and making allowance for stub end and other losses during welding.

Also the weight of weld metal = Volume of weld × Density of weld material

2. Direct Labour Cost

The direct labour cost is the cost of labour for preparation, welding and finishing operations. Preparation or pre-welding labour cost is the cost associated with preparation of job for welding, *i.e.,* the edge preparation, machining the sections to be welded etc. If gas is used in cutting/preparation of edges, its cost is also taken care of.

Cost of labour in actual welding operation is calculated considering the time in which arc is actually in operation.

The cost of labour for finishing operation is the cost of labour involved in grinding, machining, sand or shot blasting, heat treatment or painting of welded joints.

3. Direct Other Expenses

The direct other expenses include the cost of power consumed, cost of fixtures used for a particular job etc.

Cost of power : The cost of power consumed in arc welding can be calculated from the
following formula :

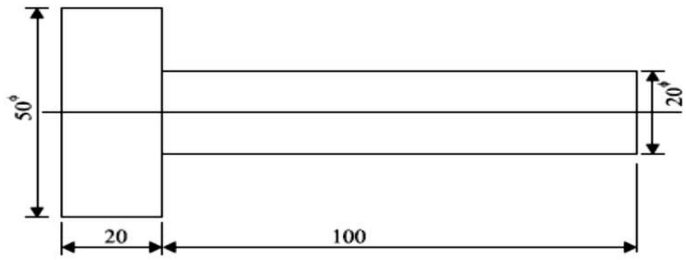
$$\text{Power cost} = \frac{V \times A}{1{,}000} \times \frac{t}{60} \times \frac{1}{E} \times \frac{1}{r} \times C$$

Where V = Voltage
A = Current in Amperes
t = Welding time in minutes
E = Efficiency of the welding machine
= 0.6 for welding transformer
= 0.25 for welding generator
r = Ratio of operating time to connecting time taken by the operator
C = Cost of electricity per kWh *i.e.,* Unit.

Overheads

The overheads include the expenses due to office and supervisory staff, lighting charges of office and plant, inspection, transport, cost of consumables and other charges. The cost of equipment is also apportioned to the individual components in the form of depreciation.

3. **150 components, as shown in Fig. are to be made by upsetting a dia 20 mm bar. Calculate the net weight, gross weight and length of dia 20 mm bar required. The density of material may be taken as 7.86 gms/cc. (10 marks) (AU M/J '16)**



Solution :

$$\text{Net volume of material} = \frac{\pi}{4}[(5)^2 \times 2 + (2)^2 \times 10]$$

$$= \frac{\pi}{4}(50 + 40) = 70.72 \text{ cm}^3$$

Net weight per component = 70.72 × 7.86 = 556 gms

Net weight for 150 components = 556 × 150 = 83,400 gms

= 83.4 kgs

Losses :

Shear loss = 5 percent of net weight

$$= \frac{5}{100} \times 556 = 27.8 \text{ gms}$$

Scale loss = 6% of net weight

$$= \frac{6}{100} \times 556 = 33.4 \text{ gms}$$

Gross weight/component = 556 + 27.8 + 33.4

= 617 gms

Gross weight for 150 components = 617 × 150 = 92,550 gms

= 92.550 kgs

$$\text{Length of 20 mm f bar required} = \frac{92550}{\frac{\pi}{4}(2)^2 \times 7.86}$$

= 3744 cms = 37.44 meters.

4. **Two 1 m long M.S plates of 10 mm thickness are to be welded by a lap joint with a 8 mm electrode. Calculate the cost of welding. Assume the following data.**
   - ***(i)*** **Current used = 30 amperes**
   - ***(ii)*** **Voltage = 300 V**
   - ***(iii)*** **Welding speed = 10 m/hr**
   - ***(iv)*** **Electrode used = 0.1 kg/m of welding**
   - ***(v)*** **Labour charges = Rs. 4.00/hr**
   - ***(vi)*** **Power charges = Rs. 0.2/kWh**
   - ***(vii)*** **Cost of electrode = Rs. 40.00/kg**

(viii) **Efficiency of machine = 70%** **(16 marks) (AU M/J '12)**

Solution

(a) Cost of electrode required for 1 m length of welding = 0.1 kg

Cost of electrode as Rs. 40/kg = 40 × 0.1 = Rs. 4.

(b) Labour cost

Time required for welding 1 m length

$$= \frac{1}{10} \text{ hr}$$

Labour charge $= \frac{1}{10} \times 4 = \text{Rs. } 0.4$

(c) Power charges, as power consumed

$$= \frac{V \times I}{\text{Efficiency of the machine}}$$

$$= \frac{300 \times 30}{0.7} = 12.85 \text{ kW}$$

Energy consumed for welding 1 m length

$$= 12.85 \times \frac{1}{10} = 1.285 \text{ kWh}$$

Power charges at Rs. 0.1/kWh = 1.28 × 0.4

= Rs. 0.512

Total welding cost = Cost of electrode + Labour charges + Power charges

= 4 + 0.4 + 0.512 = Rs. 4.912.

5. **Generalize the meaning of Tonghold loss in forging. (6 marks) (AU N/D '16)**

This is the loss of material due to a projection at one end of the forging to be used for holding it with a pair of tongs and turning it round and round to give the required cross section in drop forging. About 1.25 cm and 2.5 cm of the size of the bar is used for tonghold. The tonghold loss is equal to the volume of the protections. For example, the tonghold loss for a bar of 2 cm diameter will be

$$= \frac{\pi}{2}(2)^2 \times 1.25 \; cu.cm$$

6. **State and explain various losses which are to be considered in a forging shop. (8 marks) (AU N/D '16) (AU N/D '17)**

Losses in Forging

It is well known that some metal is always lost in the different operations of forging and this lost metal must be added to the net weight before calculating the material cost. The different losses to be considered are:

a) Scale loss
b) Flash loss
c) Tonghold loss
d) Sprue loss
e) Shear loss

(i) Scale loss

This is the material lost because of the surface oxidation in heating and forging the piece. When iron is heated at a high temperature in atmospheric conditions a thin of iron oxide is formed all round the surface of the heated metal which goes as a waste. The iron oxide film is known as scale and it falls from the surface of the metal on being beaten up by the hammer. Scale loss depends upon the surface area, heating time and the type of material. For forgings under 5 kg loss is 7.5 per cent of the net weight, and for forgings from 5 to 12.5 kg and over an addition of 6 per cent and 5 per cent of the net weight is necessary for scale loss.

(ii) Flash loss

There is a certain quantity of metal which comes between the flat surfaces of the two dies after the die cavity has been filled in. This material equal to the area of the flat surface is a wastage. For finding the flash loss, the circumference is determined which multiplied by cross-sectional area of flash will give the volume of the flash. The volume multiplied by material density gives the flash loss. Generally, it is taken as 3 mm thick and 2 mm wide all round the circumference.

(iii) Tonghold loss

This is the loss of material due to a projection at one end of the forging to be used for holding it with a pair of tongs and turning it round and round to give the required cross section in drop forging. About 1.25 cm and 2.5 cm of the size of the bar is used for tonghold. The tonghold loss is equal to the volume of the protections. For example, the tonghold loss for a bar of 2 cm diameter will be

$$= \frac{\pi}{2}(2)^2 \times 1.25 \text{ cu.cm}$$

(iv) Sprue loss

The connection between the forging and tonghold is called the sprue or runner. The material loss due to this portion of the metal used as a contact is called sprue loss. The sprue must be heavy enough to permit lifting the workpiece out of the impression die without bending. The sprue loss is generally 7.5 per cent of the net weight.

(v) Shear loss

In forging, the long bars or billets are cut into required length by means of a sawing machine. The material consumed in the form of saw-dust or pieces of smaller dimensions left as defective pieces is called shear loss. This is usually taken as 5% of the net weight. From above we see that nearly 15 to 20% of the net weight of metal is lost during forging. And as already said these losses must be added to the net weight to get the gross weight of the material.

7. **A factory produces 100 bolts and nuts per hour on a machine. Material cost is Rs. 375, labour Rs. 245 and direct expense 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. (10 marks) (AU N/D '15)**

Solution

Material cost = 375.00
Labour = 245.00
Direct expenses = 80.00
Factory 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
= 1067.50 X 0.3
= Rs. 320.25

Total cost = 1067.50 + 320.25
= 1387/-

Cost per nut = 1387/100
= 13.87/-

Sales price = 11.30

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

8. Estimate the selling price per piece of a casting component from the following data :

Net weight of cast component = 5.117 kg
Density of material = 7.2 gms/cc
Cost of molten metal at cupola spout = Rs. 20 per kg
Process scrap = 20 percent of net weight
Scrap return value = Rs. 6 per kg
Administrative overheads = Rs. 30 per hour
Sales overheads = 20 percent of factory cost
Profit = 20 percent of factory cost

Other expenditures are:

Operation	*Time (min)*	*Labour cost/hr (Rs.)*	*Shop overheads/hr (Rs.)*
Moulding and pouring	15	20	60
Shot blasting	5	10	40
Fettling	6	10	40

(16 marks) (AU N/D '13)

(*i*) *Material cost :*

Net weight of cast component = 5.117 kg

Process scrap = 20 percent of 5.117 kg
= 0.2 × 5.117 = 1.02 kg

Total metal required per component = 5.12 + 1.02 = 6.14 kg

Cost of metal poured = 6.14 × 20 = Rs. 122.8

Process return value = 1.02 × 6 = Rs. 6.12

Material cost per component = 122.8 – 6.1 = Rs. 116.7

(*ii*) *Labour cost and factory overheads :*

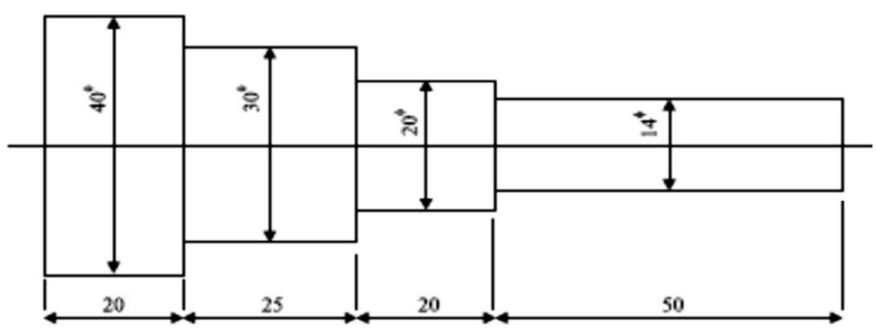
Labour cost = Rs. 6.83

Shop overheads = Rs. 22.33

Process	*Time per piece (Minutes)*	*Labour cost per piece (Rs.)*	*Shop overheads per piece (Rs.)*
Melting and pouring	15	5.00	15.00
Shot blast	5	0.83	3.33
Fettling	6	1.00	4.00
Total	**26 min**	**6.83**	**22.33**

(*iii*) Factory cost per component = 116.70 + 6.83 + 22.33 = Rs. 145.86
(*iv*) Administrative overheads = (30 × 26) /60 = Rs. 13
(*v*) Sales overheads = 0.2 × 145.86 = Rs. 29.17
(*vi*) Profit = 0.2 × 145.86 = Rs. 29.17
Selling price per component = Factory cost + Administrative overheads+ Sales overheads + profit
= 145.86 + 13 + 29.17 + 29.17
= Rs. 217.2

9. **Calculate the net weight and gross weight for the component shown in Fig. Density of material used is 7.86 gm/cc. (6 marks)**
Also calculate :
(*i*) Length of 14 mm dia bar required to forge one component. (4 marks)
(*ii*) Cost of forging/piece if: (6 marks)
Material cost = Rs. 80 per kg
Labour cost = Rs. 5 per piece
Overheads = 150 percent of labour cost. (16 marks) (AU N/D '13) (AU A/M '17)



$$\text{Net volume of forged component} = \frac{\pi}{4}[(4)^2 \times 2 + (3)^2 \times 2.5 + (2)^2 \times 2 + (1.4)^2 \times 5]$$

$$= \frac{\pi}{4}(72.3) = 56.76 \text{ cc}$$

$$\text{Net weight} = 56.76 \times 7.86 = 446 \text{ gms}$$

Losses :

Shear loss = 5 percent of net weight

$$= \frac{5}{100} \times 446 = 22.30 \text{ gms}$$

Scale loss = 6 percent of net weight

$$= \frac{6}{100} \times 446 = 26.76 \text{ gms}$$

Taking flash width = 20 mm

Flash thickness = 3 mm

Flash loss = (periphery of parting line) × 2 × 0.3 × 7.86

= [2 (2 + 2.5 + 2 + 5) + 1.4 + (2 – 1.4) + (3 – 2) + (4 – 3) + 4] × 2 × 0.3 × 7.86

= 31.0 × 2 × 0.3 × 7.86 = 146 gms

Tonghold loss = 2 × Area of cross-section of bar × 7.86

$$= 2 \times \frac{\pi}{4}(1.4)^2 \times 7.86 = 24.22 \text{ gms}$$

Sprue loss = 7 percent of net weight

$$= \frac{7}{100} \times 446 \text{ gms}$$

= 31.22 gms

Total material loss = 22.3 + 26.8 + 146 + 24.22 + 31.22

= 250 gms

Gross weight = Net weight + Losses

= 446 + 250 = 696 gms

(*i*) New length of 14 mm f bar required per piece

$$= \frac{\text{Volume of forging}}{\text{Area of X – Section of bar}}$$

$$= \frac{56.76}{\frac{\pi}{4}(1.4)^2} = 36.86 \text{ cm}$$

$$\text{Direct material cost} = \frac{696}{1{,}000} \times 8$$

= Rs. 5.57

Direct labour cost = Rs. 5 per piece

Overheads = 150 percent f labour cost

= 1.5 × 5 = Rs. 7.5

Cost per piece = 5.57 + 5 + 7.5

= Rs. 18

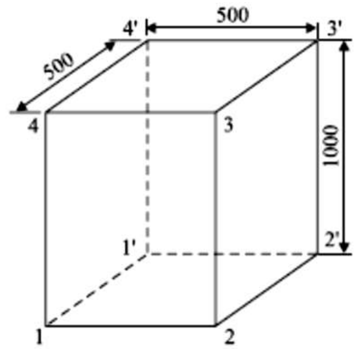
10. A container open on one side of size 0.5 m × 0.5 m × 1 m is to be fabricated from 6 mm thick plates Fig. The plate metal weighs 8 gms/cc. If the joints are to be welded, make calculations for the cost of container. The relevant data is :

Cost of plate = Rs. 10 per kg

Sheet metal scarp (wastage) = 5 percent of material

Cost of labour = 10 percent of sheet metal cost

Cost of welding material = Rs. 20 per meter of weld. (16 marks) (AU A/M ’17)



Solution :

(*i*) To calculate material cost :

Net volume of material used = (4 × 50 × 100 × 0.6) + (50 × 50 × 0.6) = 13,500 cc

Net weight of container = Volume × density of material

= 13,500 × 8 = 1,08,000 gm = 108 kgs

Sheet metal scrap = 5 percent of net weight

$$= \frac{108 \times 5}{100} = 5.40 \text{ kgs}$$

Total weight of sheet metal required for fabrication of one container

= 108 + 5.4 = 113.4 kgs

Cost of sheet metal per container = 113.4 × 10 = Rs. 1134

(*ii*) To calculate labour charges :

Cost of labour = 10 percent of sheet metal cost

$$= \frac{1134 \times 10}{100} = \text{Rs. } 113$$

(*iii*) To calculate cost of welding material :

Length to be welded = (4 × 50) + (4 × 100) = 600 cm = 6 meters

Cost of welding material = 6 × 20 = Rs. 120

(*iv*) Cost of container = Cost of sheet metal material + Cost of labour + Cost of welding material

= 1134 + 113 + 120 = Rs. 1367

11. Work out the welding cost for a cylindrical boiler drum 2 ½ × 1 m diameter which is to be made from 15 mm thick m.s plates. Both the ends are closed by arc welding of circular plates to the drum. Cylindrical portion is welded along the longitudinal seam and welding is done both in inner and outer sides. Assume the following data:

(*i*) Rate of welding = 2 meters per hour on inner side and 2.5 meters per hour on outer side

(*ii*) Length of electrodes required = 1.5 m/ meter of weld length

(*iii*) Cost of electrode = Rs. 0.60 per meter

(*iv*) Power consumption = 4 kWh/meter of weld

(*v*) Power charges = Rs. 3/kWh

(*vi*) Labour charges = Rs. 40/hour

(*vii*) Other overheads = 200 percent of prime cost

(*viii*) Discarded electrodes = 5 percent

(*ix*) Fatigue and setting up time = 6 percent of welding time. (16 marks) (AU N/D '17) (AU A/M '18)

Diameter of drum = 1 meter

Length of drum = 2.5 meter

As the cylindrical portion is welded on both sides and both the ends are closed by welding circular plates, the welding on circular plates being on one side only.

Length of weld = 2 × p × dia of drum + (2 × length of drum)
= 2 × p × 1 + (2 × 2.5)
= 11.28 meters ≈11.3 meters.

(*i*) To calculate direct material cost: In this example the cost of electrodes is the direct materiel cost.

Length of electrode required = 1.5 m/m of weld

Net electrode length required for 11.3 meters weld length = 1.5 × 11.3 = 16.95 meters

Discarded electrode = 5 percent

Total length of electrodes required = 16.95 + [(5 × 16.95)/100] = 17.8 meters

Cost of electrodes = 0.6 × 17.8 = Rs. 10.68.

(*ii*) To calculate direct labour cost: To calculate the labour charges, first we have to calculate the time required for making the weld (assuming that side plates have single side welding and longitudinal seam is welded on both sides).

Length of weld on inside of drum = 2.5 meter

Length of weld on outside of drum = 2 × p × 1 + (2.5) = 8.8 meters

Time taken for inside weld = (2.5 × 1)/2 = 1.25 hrs

Time taken for outside weld = (8.8 × 1)/2.5 = 3.5 hrs

Net time required for welding = 1.25 + 3.5 = 4.75 hrs

Fatigue and setting up allowances = 4.75 × 0.06 = 0.28 hrs

Total time required = 4.75 + 0.28 = 5 hrs

Direct labour cost = 40 × 5 = Rs. 200

(*iii*) To calculate cost of power consumed

Power consumption = 4 × 11.3 = 45.2 kWh

Cost of power consumed = 45.2 × 3 = Rs. 135.6

(*iv*) To calculate the overhead charges:

Prime cost = Direct material cost + Direct labour cost + Direct other expenses

Prime cost = 10.68 + 200 + 135.60 = Rs. 346

Overheads = (200 x 346)/100 = Rs. 692

(*v*) Total cost of making boiler drum = 10.68 + 200 + 135.6 + 692 = Rs. 1038

12. List the various sections that will be normally found in a foundry shop. (4 marks) (AU N/D '17)

Generally a foundry shop has the following sections :

1. Pattern Making Section

In this section the patterns for making the moulds are manufactured. The machines involved in making the patterns are very costly and small foundries may not be able to afford these machines. In such cases the pattern are got made for outside parties who are specialists in pattern making. Patterns are made either from wood or from a metal.

2. Sand-mixing Section

In this section raw sand is washed to remove clay etc., and various ingredients are added in the sand for making the cores and moulds.

3. Core-making Section

Cores are made in this section and used in moulds to provide holes or cavities in the castings.

4. Mould Making Section

This is the section where moulds are made with the help of patterns. The moulds may be made manually or with moulding machines.

5. Melting Section

Metal is melted in the furnace and desired composition of metal is attained by adding various constituents. Metal may be melted in a cupola or in an induction or in an arc furnace. In some cases pit furnace is also used for melting the metals.

6. Fettling Section

The molten metal after pouring in the moulds is allowed to cool and the casting is then taken out of mould. The casting is then cleaned to remove sand and extra material and is shot blasted in fettling section. In fettling operation risers, runners and gates are cut off and removed.

7. Inspection Section

The castings are inspected in the inspection section before being sent out of the factory.