



SEMBODAI RUKMANI VARATHARAJAN ENGINEERING COLLEGE

(Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai)
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DEPARTMENT OF MECHANICAL ENGINEERING

COURSE FILE

VII SEMESTER

ME8793 PROCESS PLANNING & COST ESTIMATION

(Regulation 2017-Anna University)

SEMBODAI RUKMANI VARATHARAJAN ENGINEERING COLLEGE

Vision of Institution

Striving willfully with might to develop and nurture the younger generation to emerge as better technocrats for development of the state and the country as a whole.

Mission of Institution

Minting out skillfully competent, Socially-Committed and Versatile Knowledge personalities to encounter the challenges of the society in the field of Engineering and Technology as a whole.

DEPARTMENT OF MECHANICAL ENGINEERING

Vision of Department

To create excellent professionals in the field of Mechanical Engineering and to uplift the quality of technical education on par with the International Standards.

Mission of Department

1. To reinforce the fundamentals of Science and Mathematics to Mechanical Engineering and critically and relatively investigate complex mechanical systems and processes.
2. To engage in the production, expansion and practice of advanced engineering applications through knowledge sharing activities by interacting with global communities and industries.
3. To equip students with engineering ethics, professional roles, corporate social responsibility and life skills and apply them for the betterment of society.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

Bachelor of Mechanical Engineering curriculum is designed to impart Knowledge, Skill and Attitude on the graduates to

1. Have a successful career in Mechanical Engineering and allied industries.
2. Have expertise in the areas of Design, Thermal, Materials and Manufacturing.
3. Contribute towards technological development through academic research and industrial practices.
4. Practice their profession with good communication, leadership, ethics and social responsibility.
5. Graduates will adapt to evolving technologies through life-long learning.

PROGRAMME OUTCOMES (POs)

1. An ability to apply knowledge of mathematics and engineering sciences to develop mathematical models for industrial problems.
2. An ability to identify, formulates, and solve complex engineering problems. with high degree of competence.
3. An ability to design and conduct experiments, as well as to analyze and interpret data obtained through those experiments.
4. An ability to design mechanical systems, component, or a process to meet desired needs within the realistic constraints such as environmental, social, political and economic sustainability.
5. An ability to use modern tools, software and equipment to analyze multidisciplinary problems.
6. An ability to demonstrate on professional and ethical responsibilities.
7. An ability to communicate, write reports and express research findings in a scientific community.
8. An ability to adapt quickly to the global changes and contemporary practices.
9. An ability to engage in life-long learning.

PROGRAMME SPECIFIC OUTCOMES (PEOs)

1. To understand the basic concept of various mechanical engineering field such as design, manufacturing, thermal and industrial engineering.
2. To apply the knowledge in advanced mechanical system and processes by using design and analysis techniques.
3. To develop student's professional skills to meet the industry requirements and entrepreneurial skills for improving nation's economy stronger.

COURSE SYLLABUS:

ME8793 PROCESS PLANNING & COST ESTIMATION

L T P C

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OBJECTIVES:

1. To introduce the process planning concepts to make cost estimation for various products after process planning.
2. To introduce the process planning concepts to make cost estimation for various products after process planning.
3. To perform estimation of machining time for various manufacturing operations

UNIT I INTRODUCTION TO PROCESS PLANNING

9

Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection

UNIT II PROCESS PLANNING ACTIVITIES

9

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

9

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

9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

UNIT V MACHINING TIME CALCULATION

9

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 PERIODS

COURSE OUTCOMES (COs)

At the end of the course, students would:

CO-1	Select the process, equipment and tools for various industrial products.
CO-2	Prepare process planning activity chart.
CO-3	Explain the concept of cost estimation.
CO-4	Compute the job order cost for different type of shop floor.
CO-5	Calculate the machining time for various machining operations.

TEXTBOOKS

TEXT BOOK-1:

Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science Technology Books, Dec 2002 .

TEXT BOOK-2:

Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 1995.

REFERENCES:

RB.1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.th

RB.2. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9 1998.
Edition, John Wiley,

RB.3. Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.

RB.4. Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001.

RB.5. Dr.V.Jeyakumar., "Process planning and cost estimation", 12th Edition, Lakshmi Publications, 2017

Question Bank:

ME8793 PROCESS PLANNING & COST ESTIMATION

UNIT I INTRODUCTION TO PROCESS PLANNING**Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection-.Production equipment and tooling selection****PART – A****CO Mapping : C205.1**

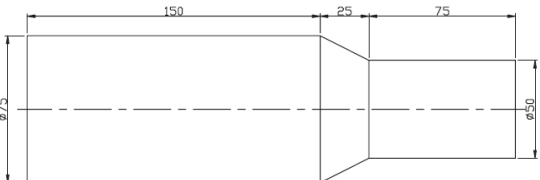
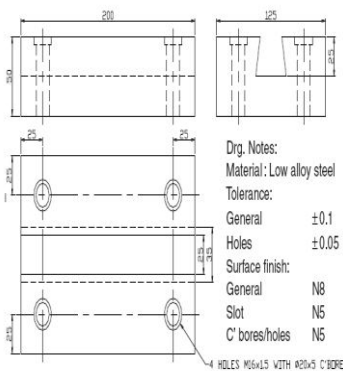
Q. No	Questions	BT Level	Competence	PO
1	Define process planning.	BTL-1	Remembering	PO1,PO2
2	Select the process parameter for setting machines and tooling's.		Understanding	
3	Identify the process planning activities.	BTL-3	Analyzing	PO1,PO2
4	Summarize the factors influencing process selection.	BTL-1	Remembering	PO1,PO2
5	Summarize the use of drawings interpretation in processing requirement.	BTL-2	Understanding	PO1
6	Quote the data is listed for each component of the product in the process sheet.	BTL-2	Understanding	PO1
7	List the use of process Sheet.	BTL-1	Remembering	PO1
8	Prioritize the sort of information can the process planner obtained from the engineering drawing of the component.	BTL-1	Remembering	PO1
9	Give a procedure for process planning for the manufacture of a component in machine shop.	BTL-5	Evaluating	PO1
10	List the objectives of process planning.	BTL-2	Understanding	PO1
11	Discuss the various parameters considered in the material selection?	BTL-1	Remembering	PO1
12	Illustrate briefly the characteristics of realistic estimates?	BTL-2	Understanding	PO1
13	Show the steps involved in process design	BTL-3	Understanding	PO1,PO2
14	Classify the work holding Devices and why they are used.	BTL-1	Remembering	PO1,PO2
15	Point out the main inputs and outputs for process planning activity.	BTL-4	Understanding	PO1
16	Explain briefly about depreciation?	BTL-6	Creating	PO1,PO2
17	Originate the advantages and disadvantages of process planning	BTL-4	Analyzing	PO1,PO2
18	Assume a process flow chart and how would it be used to help formulate a process plan	BTL-5	Evaluating	PO1
19	Categorize the main approaches of process planning.	BTL-4	Understanding	PO1,PO2
20	Compose the documents required for Process	BTL-6	Creating	PO1,PO2

	Planning?			
PART – B				
1	(a) Identify the steps involved in Process Design. (b) Examine the basic factors affecting Process Design.	BTL-2 BTL-1	Understanding Remembering	PO1,PO2,PO3
2	(a) Describe the steps or procedures involved in Process Planning. (b) Show the data is listed for each component of the product in the process sheet	BTL-2 BTL-1	Understanding Remembering	PO1,PO2,PO3
3	Explain with neat sketch and the steps followed for material selection process and methods.	BTL-1	Remembering	PO1,PO2,PO3, PO5, PO6,PO9, PO12,
4	Show the two approaches to Process Planning in the context of CAPP (Computer Aided Process Planning)? Explain them clearly.	BTL-5	Evaluating	PO1,PO2,PO3, PO4
5	Describe step by step procedure for estimating the direct material cost	BTL-5	Evaluating	PO1,PO2,PO3, PO4
6	(a) Discuss the various parameters considered in the material selection?	BTL-2	Understanding	PO1, PO2,PO3
	(b) Summarize the documents required for Process Planning?	BTL-1	Remembering	
7	(a) Classify the four distinct processing strategies Give the basic steps in cost estimation.	BTL-2	Understanding	PO1, PO2,PO3
	(b) Summarize the process layout with neat sketch.	BTL-2	Remembering	
UNIT II PROCESS PLANNING ACTIVITIES 10				
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				
PART – A				
CO Mapping : C205.2				
Q .No	Questions	BT Level	Competence	PO
1	Give the factors that considered in Depth of Cut.	BTL-2	Understanding	PO2,PO3
2	List the factors Considered for selecting Process	BTL-1	Remembering	PO1, PO2,PO3

	parameter.			
3	A planer is capable of 15 strokes per minute over a stroke length of 2m. The cutting time ratio for the machine is 4:3. Determine cutting speed.	BTL-1	Remembering	PO1, PO2, PO3
4	Infer the factors previously considered for the tooling decision are the most influential on the calculation of the process parameters.	BTL-3	Applying	PO1, PO2
5	What are the general recommendations for cutting depths for turning and boring?	BTL-2	Understanding	PO1, PO3, PO4
6	Define cutting speed.	BTL-1	Remembering	PO1, PO2, PO4
7	Classify how milling operations can be classified.	BTL-2	Understanding	PO1, PO2
8	Classify the three basic functions of Jig.	BTL-3	Applying	PO1, PO2
9	Show the general factors that will influence the design and/or construction of a work holder.	BTL-3	Applying	PO1, PO2
10	Analyze the basic principles of jig and fixture design can be categorized	BTL-4	Analyzing	PO1, PO4
11	Show the main reasons for the use of jigs and fixtures.	BTL-1	Remembering	PO1, PO2
12	Draw the flow chart for design methodology for work holders	BTL-6	Creating	PO1, PO4
13	Categorize the main factors to be considered for work holding device.	BTL-4	Evaluating	PO1, PO2, PO4
14	Point out the quality function for process plan	BTL-4	Evaluating	PO1
15	Discuss how does the process planner use cost data?	BTL-6	Creating	PO1
16	Assess the three elements of Direct cost	BTL-5	Evaluating	PO1
17	Define press forging	BTL-5	Evaluating	PO1
18	Summarize major influences on the cost of materials for manufacture	BTL-1	Remembering	PO1, PO4
19	Quote the purpose of work holding Devices	BTL-1	Remembering	PO1, PO2
20	Calculate the spindle speed required to turn a 75mm diameter shoulder on a low- carbon steel component using a high-speed steel tool. What is the percentage increase in cutting speed if a carbide tool is used instead?	BTL-2	Understanding	PO1, PO2
21	Illustrate the formula to calculate the machining times for turning and boring.	BTL-1	Remembering	PO1, PO2

PART – B & C

1	The top surface of the aluminum alloy component shown in Fig is to be milled by slab milling. It will be machined by a $\varnothing 20$ mm HSS cutter with eight cutting teeth at a constant surface speed of 45 m min^{-1} . The depth of cut is 4 mm and the milling machine is capable of spindle speeds	BTL-1	Remembering	PO1, PO2,
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	<p>of up to 3000 rpm. Determine:</p> <p>(i) if the mill is capable of machining the component at the required surface speed</p> <p>(ii) the total machining time for the component if the mill is capable.</p>			
<p>2</p>	<p>Summarize the general recommendations for cutting depths for turning, boring, milling and Drilling?</p>	<p>BTL-2</p>	<p>Understanding</p>	<p>PO1,PO2</p>
<p>3</p>	<p>For the part shown in Fig. calculate the maximum surface speeds for facing, turning all surfaces and parting off. The maximum spindle speed of the lathe being used is 600rpm</p> 	<p>BTL-1</p>	<p>Remembering</p>	<p>PO1,PO2,PO4</p>
<p>4</p>	<p>Consider the component shown in Fig, and design a suitable type of jig for drilling the $\varnothing 10$ mm holes, assuming the holes are manufactured last.</p>  <p>Drng. Notes: Material: Low alloy steel Tolerance: General ± 0.1 Holes ± 0.05 Surface finish: General N8 Slot N5 C' bores/holes N5</p> <p>HOLE'S M8&15 WITH REQS C'BORE</p>	<p>BTL-3</p>	<p>Applying</p>	<p>PO1,PO2</p>

5	Calculate the spindle speed required to turn a 75mm diameter shoulder on a low- carbon steel component using a high-speed steel tool. What is the percentage increase in cutting speed if a carbide tool is used instead?	BTL-1	Remembering	PO1, PO2,PO3
6	Describe depth of cut and what are the most important factors that affect the depth of cut possible when machining?	BTL-1	Remembering	PO1, PO2,PO3

UNIT III INTRODUCTION TO COST ESTIMATION 8

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

PART – A

CO Mapping : C205.3

Q.No	Questions	BT Level	Competence	PO
1	Define cost accounting	BTL-1	Remembering	PO1
2	Distinguish between cost estimation and cost accounting	BTL-2	Understanding	PO1
3	List the types of estimates	BTL-1	Remembering	PO1
4	Classify the sources of cost estimation?	BTL-4	Analyzing	PO1
5	Point out any two objectives of cost estimation	BTL-4	Analyzing	PO1,PO4
6	Summarize batch costing	BTL-5	Evaluating	PO1
7	Describe briefly standard data	BTL-2	Understanding	PO1

8	Define under estimate	BTL-1	Remembering	PO1,PO2
9	Explain about target cost	BTL-4	Understanding	PO1,PO4
10	Explain briefly about conceptual cost estimating	BTL-5	Evaluating	PO1,PO2
11	Define contingency allowances	BTL-1	Remembering	PO1
12	Illustrate briefly the characteristics of realistic estimates?	BTL-3	Applying	PO1,PO2
13	Classify the allowances considered in cost estimation	BTL-3	Applying	PO1,PO2
14	Give the methods of costing	BTL-2	Understanding	PO1,PO2
15	Demonstrate how the standard data is developed?	BTL-3	Applying	PO1
16	Explain briefly about depreciation?	BTL-4	Remembering	PO1
17	Define multiple cost method	BTL-1	Remembering	PO1,PO2,PO4
18	Generalize the meaning direct material with an example	BTL-6	Creating	PO1
19	Give any two functions of cost estimation	BTL-2	Understanding	PO1
20	Define parametric estimating	BTL-1	Remembering	PO1,PO2

PART – B & C

1	(a) Discuss the objectives of cost estimation (b) Give the advantages of cost accounting	BTL-5	Evaluating	PO1,PO2,PO4
2	With suitable application examples classify costs	BTL-5	Evaluating	PO1,PO2, PO3,PO4
3	(a) Discuss various types of estimates (b) Explain the data requirements for cost estimation and their sources	BTL-5	Evaluating	PO1,PO2,PO3
4	(a) Describe the different methods of estimates (b) Explain the allowances in estimation	BTL-4	Analyzing	PO1,PO2, PO3
5	Describe step by step procedure for estimating the direct material cost	BTL-5	Evaluating	PO1,PO2
6	Explain the various allowances to be considered in estimation of direct labour cost	BTL-1	Remembering	PO1,PO2, PO3
7	(a) Differentiate cost accounting and cost estimating (b) Give the basic steps in cost estimation	BTL-4 BTL-2	Understanding Understanding	PO1,PO2, PO3

UNIT IV PRODUCTION COST ESTIMATION

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop

PART – A

CO Mapping : C205.4

Q. No	Questions	BT Level	Competence	PO
1	How do you estimate the time required for forging?	BTL-2	Understanding	PO1,PO2
2	Explain the actual welding costs involved in estimation in welding shop?	BTL-5	Evaluating	PO1,PO2
3	List the losses to be considered in estimating the gross weight of a forging component	BTL-1	Remembering	PO1
4	List the losses to be considered in estimating the gross weight of a forging component	BTL-5	Evaluating	PO1,PO2
5	Illustrate how to estimate the gas cutting costs	BTL-3	Remembering	PO1
6	Give the losses in forging process	BTL-2	Understanding	PO1,PO2

7	List the various sections that will be normally found in a foundry shop.	BTL-1	Remembering	PO1
8	List the various elements of cost involved in the total cost of manufacturing a casting.	BTL-1	Analyzing	PO1
9	Explain overhead expenses	BTL-4	Evaluating	PO1,PO2
10	Explain how cost estimation is done in respect of a welded component or welding job.	BTL-4	Remembering	PO1,PO2
11	List the various elements of cost involved in weldment or a welded component.	BTL-1	Analyzing	PO1,PO4
12	What are the various costs involved in the calculation of total cost of forged components.	BTL-6	Remembering	PO1,PO2
13	What is pattern making and fettling in foundry? Generalize it	BTL-2	Remembering	PO1
14	Differentiate leftward and rightward welding?	BTL-1	Remembering	PO1
15	List the types of forging processes	BTL-4	Analyzing	PO1,PO3
16	Explain machine forging or upset forging in a brief manner.	BTL-1	Remembering	PO1
17	Define press forging	BTL-6	Creating	PO1,PO3
18	Generalize the meaning of tonghold loss in forging?	BTL-4	Analyzing	PO1,PO3
19	Describe briefly a sprue loss?	BTL-2	Understanding	PO1
20	Give the formula for calculating the cost of power consumed in arc welding.	BTL-2	Understanding	PO1

PART – B & C

1	<p>A cast iron component is to be manufactured as per Fig. 5.2. Estimate the selling price per piece from the following data :</p> <p>Density of material = 7.2 gms/cc Cost of molten metal at cupola spout = Rs. 20 per kg</p> <p>Process scrap = 20 percent of net weight</p> <p>Scrap return value = Rs. 6 per kg</p> <p>Administrative overheads = Rs. 30 per hour</p> <p>Sales overheads = 20 percent of factory cost</p> <p>Profit = 20 percent of factory cost</p>	BTL-3	Applying	PO1,PO2, PO3												
	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Operation</th> <th style="text-align: center;">Time (min)</th> <th style="text-align: center;">Labour cost/hr (Rs.)</th> <th style="text-align: center;">Shop overheads/hr (Rs.)</th> </tr> </thead> <tbody> <tr> <td>Moulding and pouring</td> <td style="text-align: center;">15</td> <td style="text-align: center;">20</td> <td style="text-align: center;">60</td> </tr> <tr> <td>Shot blasting</td> <td style="text-align: center;">5</td> <td style="text-align: center;">10</td> <td style="text-align: center;">40</td> </tr> <tr> <td>Fettling</td> <td style="text-align: center;">6</td> <td style="text-align: center;">10</td> <td style="text-align: center;">40</td> </tr> </tbody> </table>				Operation	Time (min)	Labour cost/hr (Rs.)	Shop overheads/hr (Rs.)	Moulding and pouring	15	20	60	Shot blasting	5	10	40
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													

The component shown is obtained after machining the casting. The pattern which costs Rs. 5,000 can produce 1,000 pieces before being scrapped. The machining allowance is to be taken as 2mm on each side.

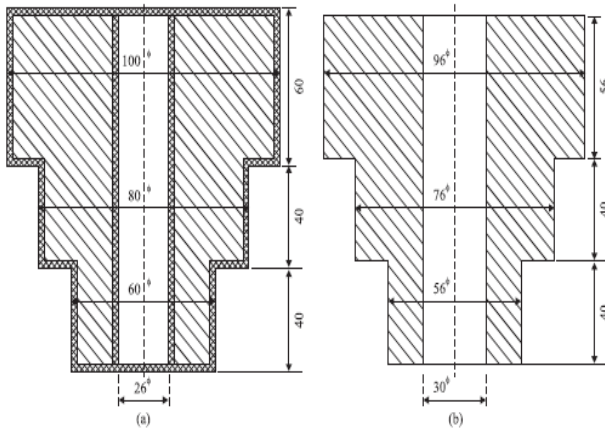


Fig. 5.2 (a) Component as cast, (b) Finished component (All dimensions are in mm).

A lap welded joint is to be made as shown in Fig. 5.4

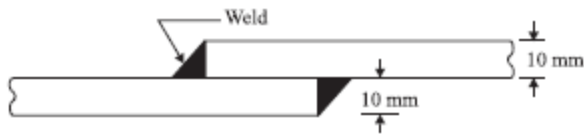


Fig. 5.4. Lap joint

2

Estimate the cost of weld from the following data :

Thickness of plate = 10 mm

Electrode diameter = 6 mm

Minimum arc voltage = 30 Volts

Current used = 250 Amperes

Welding speed = 10 meters/hour

Electrode used per meter of weld = 0.350 kgs

Labour rate = Rs. 40 per hour

Power rate = Rs. 3 per kWh

Electrode rate = Rs. 8.00 per kg

Efficiency of welding m/c = 50 percent

Connecting ratio = 0.4

BTL-3

Applying

PO1,PO2

	Overhead charges = 80 percent of direct charges Labor accomplishment factor = 60 percent			
3	Calculate the welding cost from the following data : Plate thickness =12 mm Form of joint = 60°V Root gap = 2 mm Length of joint = 2 meters Electrode diameters = 3.5 mm and 4.0 mm Electrode length = 350 mm	BTL-2	Understanding	PO1,PO2, PO4
4	(i) Describe in detail the procedure for estimating. (ii) Explain the various constituents of estimation.	BTL-1 BTL-2	Remembering Understanding	PO1,PO2,PO3
5	(i) Calculate the material cost of 20 gun metal bushes as per the diagram. Assume the density of gun metal as 8.3gm per cc and its cost is re.70 per kg. Consider 10% material loss during process. All dimension are in mm.	BTL-5	Evaluating	PO1,PO2,PO4

UNIT V MACHINING TIME CALCULATION

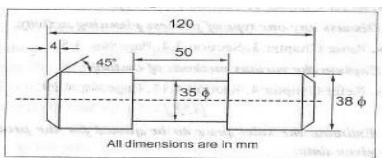
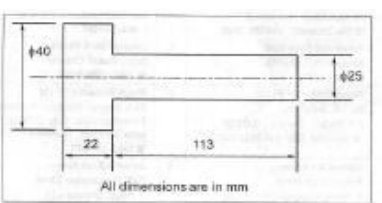
Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding

PART – A

CO Mapping : C205.5

Q.No	Questions	BT Level	Competence	PO
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1	Define Direct Expenses	BTL-1	Remembering	PO1
2	Define Indirect Expenses (Overhead Expenses)	BTL-2	Understanding	PO1,PO2
3	What are the analysis used for overhead expenses?	BTL-1	Remembering	PO1,PO3
4	Define Factory Expenses	BTL-1	Remembering	PO1
5	Define Administrative Expenses	BTL-2	Understanding	PO1
6	Define Selling Expenses .	BTL-1	Remembering	PO1
7	What you mean by distribution Expenses?	BTL-4	Analyzing	PO1,PO2
8	What are the components of cost?	BTL-2	Understanding	PO1,PO12
9	Define Prime Cost	BTL-2	Understanding	PO1,PO12
10	Define Works Cost	BTL-2	Understanding	PO12
11	Define Production or Manufacturing or Office Cost	BTL-2	Understanding	PO1
12	Define Machine or Upset Forging	BTL-2	Understanding	PO1,PO3
13	Write the forging operations.	BTL-2	Understanding	PO1
14	Define Shear Loss	BTL-2	Understanding	PO1
15	Define Tong hold Loss	BTL-1	Remembering	PO1
16	Define Scale Loss	BTL-1	Remembering	PO1
17	Define Flash Loss	BTL-4	Analyzing	PO1
18	Define Sprue Loss	BTL-1	Remembering	PO1
PART – B				
1	Briefly explain the distribution or allocation of overheads.	BTL-4	Analyzing	PO1,PO3
2	Write a critical note on the production cost estimation.	BTL-5	Evaluating	PO1,PO2,PO3
3	Estimate the machining time to turn a M.S bar of 3 cm diameter down to 2.5 cm for a length of 10 cm in a single cut. Assume cutting speed = 30	BTL-2	Understanding	PO1,PO3,PO12

	m / min and feed = 0.4 mm/ rev.			
4	<p>A mild steel bar 120mm long and 40mm in diameter is turned to 38mm diameter and was again turned to a diameter of 30mm over a length of 50mm as shown in the figure. The bar was chamfered at both the ends to give a chamfer of 45°X4mm after facing. Calculate the machining time. Assume cutting speed of 50m/min and feed 0.3 mm/per. The depth of cut is not to exceed 3mm in any operation.</p> 	BTL-2	Understanding	PO1,PO3,PO12
5	<p>Three hundred pieces of the bolt are to be made from 25mm diameter rod. Find the length of each bolt before up setting. What length of the rod is required if 4% of the length goes as scrap?</p> 	BTL-6	Creating	PO1,PO2, PO3,PO12