IE301 Product Design and innovation
Exercise (6) [Design for Manufacturing]

Manufacturing costing

1- *A part can be produced by gray iron casting or aluminum die casting. The costs for each process are given in table (1).*

Table (1)

Manufacturing process	Gray cast iron	Aluminum die cast
Fixed cost, SR	20,000	140,000
Material cost, SR/part	3	2.5
Process cost, SR/hr	24	55
Process time, min	15	6

a) *What is cost function of each process?*

b) *What is breakeven quantity?*

c) *Which process is to be selected if the production quantity is more than the breakeven quantity?*

d) *What is the quantity needed to be produced to cover the cost and start to make profit if the revenue is 20 SR/part?*

2- *Determine the cheapest process for high pressure hose fitting as shown in figure. The relative data are given in the table (2).*

Table (2)

	Turret Lathe	Automatic Single-spindle	Automatic Multi-spindle
Tooling cost, $	200	400	600
Setup time, hr	1	2	4
Setup Cost, $/hr	8	8	8
Operation Time, min.	2 (1 machine/operator)	0.6 (4 machines/operator)	0.2 (2 machines/operator)
Direct labor cost, $/hr	12	12	12
Expected product life, years	2	2	2
Annual Quantity	500	500	500
Normal lot Size	500	500	500

3- *Develop a cost model to compare the cost of drilling 1000 holes in steel plate with standard high speed steel drill and a TiN-coated high speed steel drill. Each hole is 1in deep. The drill feed is 0.010 per revolution. Machining time costs per minute and the cost of changing a tool is $5.*

Drill type	Price of a drill, $	Tool life (no. of holes)	
		500 rpm	900 rpm
Std. H.S.S.	12.00	750	80
TiN-coated H.S.S.	36.00	1700	750

(a) Compare the costs at fixed conditions of 500 rpm

(b) Compare the costs at a constant tool life of 750 holes.

4- *For a centrifugal pump consisting of 10 parts, the cost structure for a centrifugal pump and the function(s) provided by each part is given in table (4-1).*

Table (4-1) cost structure and functions of centrifugal pump parts

	Parts	Manufacturing cost type, $				Function contribution provided by each component, %					
		Material	Production	Assembly	purchase	F1: contain liquid	F2: transfer energy	F3: convert energy	F4: connect parts	F5: increase life	F6: support parts
1	Housing	3575	1375	550		50%					50%
2	Impeller	2475	1575	450			30%	70%			
3	Shaft	382.5	382.5	85			60%				40%
4	Bearing				600						100%
5	Seals				500	100%					
6	Wear rings	63	81	36						100%	
7	Bolts				50				100%		
8	Oiler				20					100%	
8	Key	4.5	7.5	3			80%		20%		
10	Gasket				10	100%					

Use the following table to connect components with the functions to which they contribute and hence identify areas of focus, and determine:

a) The cost of components and cost of functions and fill the value in the corresponding cell.

b) The total cost values indicated by arrow in the table and fill the value in the corresponding cell.

c) How can you decide on improvement requirement?

Function value

Centrifugal pump Components	Total Component Cost ↓	Total Function value →	Functions of centrifugal pumps F1	F2	F3	F4	F5	F6	Total Value of function for component ↓
Housing									
Impeller									
Shaft									
Bearing									
Seals									
Wear rings									
Bolts									
Oiler									
Key									
Gasket									
Total cost of function →									

Component cost

5- *Estimate the production cost for a simple product you may have purchased. Try costing a product with fewer than 10 components, such as floppy disk, a pen, a jackknife, or a baby's toy. Remember that one reasonable upper bound for your estimate, including overhead, is the wholesale price (between 50 percent and 70 percent of retail).*

6- *Suggest some potential cost-reducing modifications you could make to improve the product costed above. Compute the DFA index before and after these changes.*

7- *List 10 reasons why reducing the number of parts in a product might reduce production costs. Also list some reasons why costs might increase.*

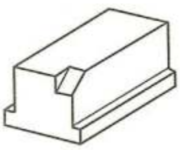
Design for Manufacturing rules

8- *Consider the following 10 "design rules" for electromechanical products. Do these seem like reasonable guidelines? Under what circumstances could one rule conflict with another one? How should such a trade-off be settled?*

(1) Minimize parts count
(2) Use modular assembly
(3) Stack assemblies
(4) Eliminate adjustments
(5) Eliminate cables
(6) Use self-fastening parts
(7) Use self-locating parts
(8) Eliminate reorientation
(9) Facilitate parts handling
(10) Specify standard parts

9- *For design for assembly, which give better assembly and why?*

a. *Chip orientation camper*



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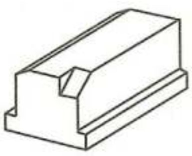
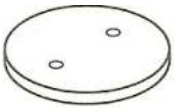


(ii)

b. *Hole orientation*



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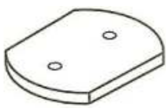


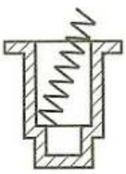
(ii)

c. *Ring guidance*

(i)

(ii)

d. *Spring guidance*



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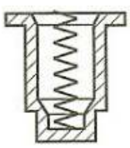
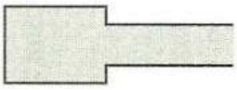
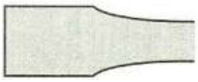


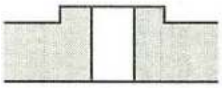
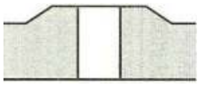
(ii)

10- *For design for casting, which give better process and why?*

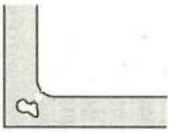
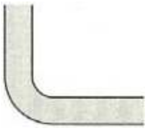
a. *Step reduction*

(i)  (ii) 

b. *Hub*

(i)  (ii) 

c. *Angle shape*

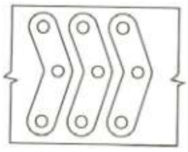
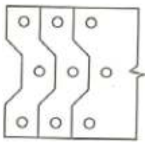
(i)  (ii) 

d. *Cross shape*

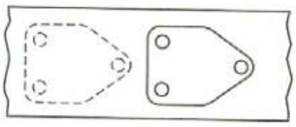
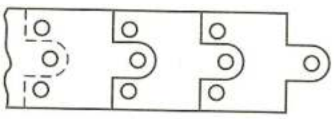
(i)  (ii) 

11- *For design for sheet metal blanking process, which is better and why?*

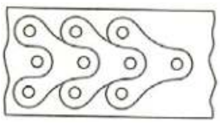
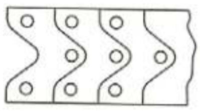
a. *Case 1*

(i)  (ii) 

b. *Case 2*

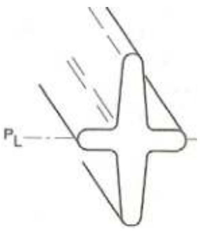
(i)  (ii) 

c. *Case 3*

(i)  (ii) 

12- *For design for forging process, which is base line is desired and why?*

a. *Case 1*



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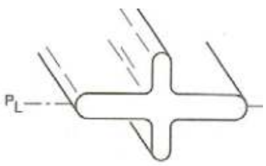
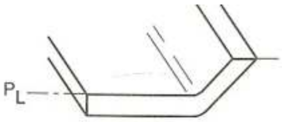


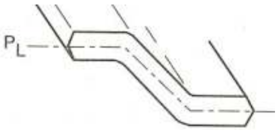
(ii)

b. *Case 2*

(i)


(ii)


c. *Case 3*

(i)


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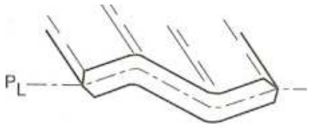
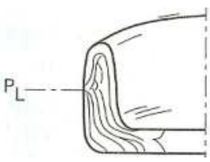


d. *Case 4*

(i)


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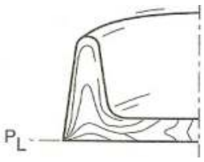

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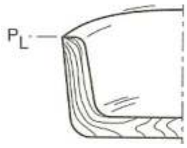
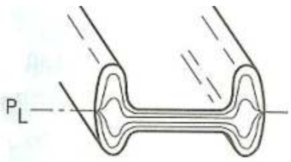


e. *Case 5*

(i)


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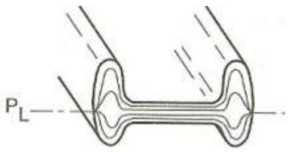

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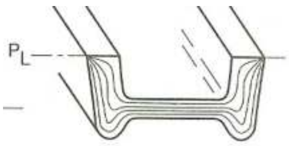
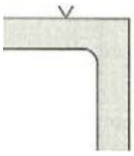


13- *For design for machining process, which is better and why?*

a. *Case 1*

(i)

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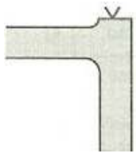
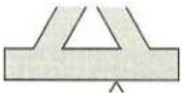


b. *Case 2*

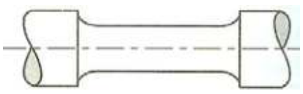
(i)

(ii)


c. *Case 3*

(i)

(ii)


d. *Case 4*

(i)

(ii)