CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESI 2011/2012

COURSE NAME	:	DESIGN FOR MANUFACTURE AND ASSEMBLY
COURSE CODE	:	BDD 4013
PROGRAM ME	:	BACHELOR OF MECHANICAL ENGINEERING WITH HONOURS
DATE OF EXAMINATION	:	JUNE 2012
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR** QUESTIONS FROM **FIVE** QUESTIONS PROVIDED

THIS QUESTION PAPER CONSISTS OF TEN (10) PRINTED PAGES

Q1 (a) State the two basic principles of Design for Assembly.

(4 marks)

(b) State the three criteria provided by Design for Assembly methodology which are used to evaluate a part for assembly.

(6 marks)

(c) Sketch the general steps of a Design for Assembly and Manufacturing process in a product development cycle.

(6 marks)

(d) With the aid of diagrams, give three examples of products which have utilized Design for Assembly and Manufacturing and resulted in simpler, sleeker and cheaper products.

(9 marks)

Q2 (a) What are the information required for the initial selection of material/process combinations?

(5 marks)

(b) In Design for Manufacturing, each manufacturing process is analysed to determine its capabilities in producing certain shape attributes. State the general shapes that can be produced by the current manufacturing processes.

(5 marks)

(c) Identify the compatibility of the process against the various design features by filling up the **Table Q2(c)** with indication of Y (process is capable of producing the design feature) , N (process is not capable of producing the feature) or M (the process must have the features).

(15 marks)

Q3 (a) In manual assembly, what are the two main factors that influence the assembly cost of a product?

(2 marks)

(b) Given a part which is to be inserted into an assembly as shown in **Figure Q3(b).** Determine its angle of symmetry.

(3 marks)

(c) Specify and discuss THREE (3) benefits of DFMA.

(6 marks)

(d) What are the advantages of a product that is assembled by automatic assembly system as compared to a product that is assembled by manual assembly.

(4 marks)

(e) Given a component as shown in **Figure Q3(e)** which is to be delivered to an automatic assembly system working at a 10 s cycle. Assume the cost of delivering simple parts using 'standard' feeder is 0.03 cents per second. The part is to be inserted horizontally and given 'standard' work head cost of 0.06 cents per second, determine the total handling (feeding) and insertion cost for this component.

(10 marks)

Q4 (a) With the aids of diagrams, describe THREE (3) types of lathe operations.

(6 marks)

(b) With the aids of diagrams, explain the term 'transient surface' in lathe operations.

(4 marks)

(c) With the aids of diagrams, illustrate two examples of design features that are impossible or very difficult to machine for rotational component.

(5 marks)

(d) Explain the term 'non productive costs' and give THREE (3) example of them.

(5 marks)

(e) **Figure Q4(e)** shows a costs (dollars) for a series of turned components. Justify why the smaller component is more expensive to machine.

(5 marks)

Q5 (a) Explain why the features listed below should be avoided when designing component to be moulded. Use sketches to highlight your points.

i) Sharp coners

(3 marks)

ii) Undercut

(3 marks)

iii) Large flat areas

(3 marks)

iv) Ribs with multiple intersection

(3 marks)

v) Non-uniform wall thickness

(3 marks)

(b) **Figure Q5(b)** shows the rectangular shape of sheet metal with size 150mm x 90mm that surround with nine holes. The perimeter of each non-standard shape for hole "**T**" and hole "C" is 80mm and 96mm respectively. By assuming that 50mm space was allowed at surrounding area of part at the die set and the die manufacture rate is RM35 per hour. Determine the cost of piercing die for drilling these nine holes?

(10 marks)

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TABLE Q2(c) : Compatibility of Manufacturing Processes and Design Features

Manufacturing Process / Design Features	Vacuum Casting	Sand Casting	Sheet metal stamping	Powder Metal Parts	Hot Extrusion	Rotary Swaging
Depression						
Captured Cavity						
Enclosed						
Uniform Section						
No Draft Surface						

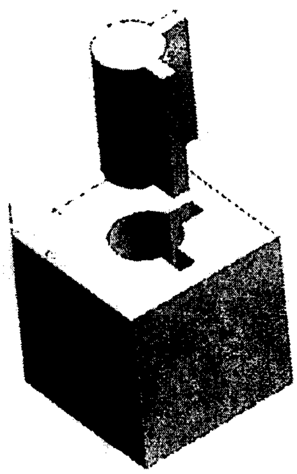

Figure Q3(b)

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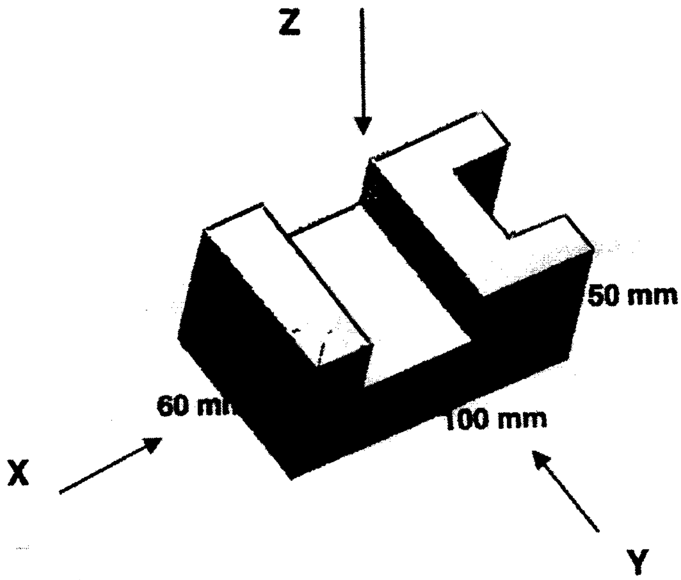
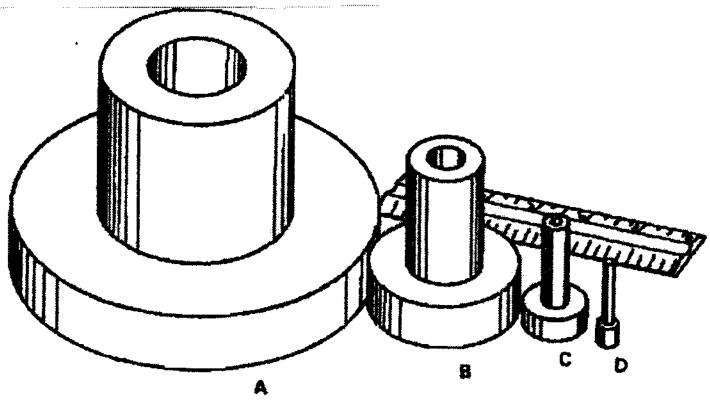


All dimensions in mm

Figure Q3(e)



	A	B	C	D
Volume of finished part (in^3)	40.0	4.0	0.4	0.04
Material cost/in^3 of finished part	0.44	0.44	0.44	0.44
Manufacturing cost/in^3	0.11	0.35	1.32	3.56
Total cost/in^3 of finished part	0.55	0.79	1.76	4.00

Figure Q4(e)

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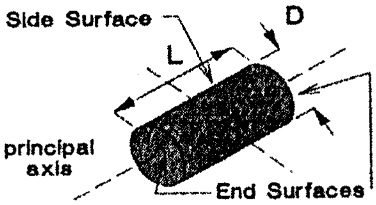
Rotational (1)	Discs L/D ≤ 0.8 (2)	0
	Short Cylinders 0.8 ≤ L/D ≤ 1.5 (2)	1
	Long Cylinders L/D > 1.5 (2)	2
Non-Rotational	Flat A/B ≤ 3 A/C > 4 (3)	6
	Long A/B > 3 (3)	7
	Cubic A/B ≤ 3 A/C ≤ 4 (3)	8

Table 1 : First digit of geometrical classification of parts for automatic handling

first digit	E	C_r
0	0.3	1
1	0.15	1.5
2	0.45	1.5



		part is symmetrical about its principal axis (BETA symmetric)	BETA asymmetric projections, steps or chamfers (can be seen in silhouette): on side surface only	on end surface(s) only	on both side and end surface(s)
		0	2	3	4
part is ALPHA symmetric	0	0.7 1 0.7 1 0.9 1	0.3 1 0.15 1 0.45 1	0.5 1 0.2 1 0.9 2	0.3 1 0.15 1 0.45 1
part can be fed in a slot supported by large end or protruding flange with center of mass below supporting surfaces	1	0.4 1 0.3 1 0.9 1	0.2 1 0.1 1 0.45 1	0.25 1 0.1 1 0.9 2	0.2 1 0.1 1 0.45 1

Table 2 : Second and third digits of geometrical classification of parts for automatic handling

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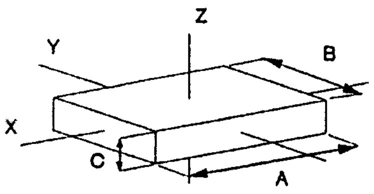
first digit	E	C_r
6 ▷	0.7	1
7 ▷	0.45	1.5
8 ▷	0.3	2



		steps or chamfers parallel to -					
		X axis and > 0.1C		Y axis and > 0.1C		Z axis and > 0.1B	
		0		1		2	
part has no symmetry (code the main feature that defines the orientation)	4	0.25	1	0.15	1	0.15	1.5
		0.25	1	0.1	1.5	0.24	2
		0.15	1	0.14	1	0.15	1

Table 3 : Second and third digits of geometrical classification for some nonrotational parts

FIGURES TO BE ADDED TO C_r				Parts will not tangle or nest			
				Not light		Light	
				Not sticky	Sticky	Not sticky	Sticky
				0	1	2	3
Parts do not tend to overlap during feeding	Not delicate	Non-flexible	0	0	1	2	3
		Flexible	1	2	3	4	5
	Delicate	Non-flexible	2	1	2	3	4
		Flexible	3	3	4	5	6

Table 4 : Additional relative feeder costs for a selection of feeding difficulties

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Key: PART ADDED but NOT SECURED

		After assembly no holding down required to maintain orientation and location (5)				Holding down required during subsequent process(es) to maintain orientation and location (5)			
		Easy to align and position (6)		Not easy to align or position (no features provided for the purpose)		Easy to align and position (6)		Not easy to align or position (no features provided for the purpose)	
		No resistance to insertion	Resistance to insertion (7)	No resistance to insertion	Resistance to insertion (7)	No resistance to insertion	Resistance to insertion (7)	No resistance to insertion	Resistance to insertion (7)
		0	1	2	3	6	7	8	9
No final securing is taking place (2) – Straight line insertion – From vertically above	0	1	1.5	1.5	2.3	1.3	2	2	3
No final securing is taking place (2) – Straight line insertion – Not from vertically above (3)	1	1.2	1.6	1.6	2.5	1.6	2.1	2.1	3.3
No final securing is taking place (2) – Insertion not straight line motion (4)	2	2	3	3	4.6	2.7	4	4	6.1

No screwing operation or plastic deformation immediately after insertion (snap or press fits, etc.)	Plastic deformation immediately after insertion				Screwing immediately after insertion
	Plastic bending		Rivetting or similar plastic deformation		
		Not easy to align or position (no features provided	(6)	Not easy to align or position (no features provided	

Table 5 : Relative workhead coasts for a selection of automatic insertation situations

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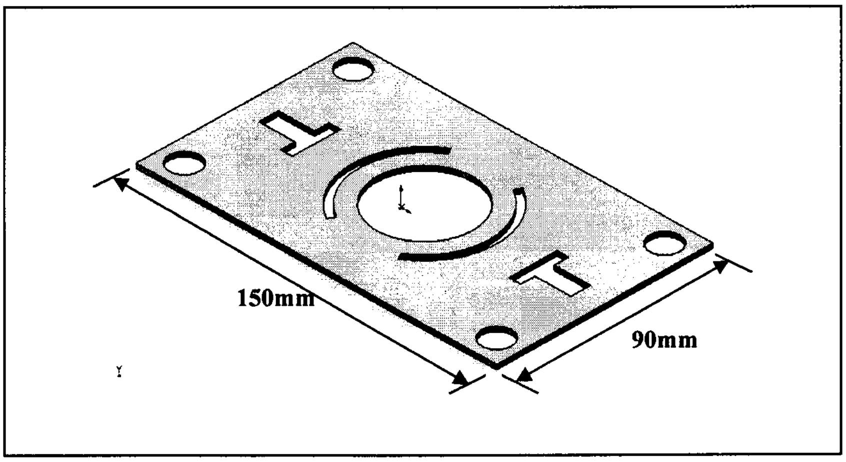

Figure Q5(b)

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List of Formula;

$C_f = (60/F_r)R_f$ cents

$C_f = 0.03(60/F_m)C_r$ cents

$F_m = 1500\ E / l$ parts/min

$R_f = C_F E_o / (5760 P_b S_n)$ cents/s

$M_{po} = 23 + 0.03LW$

F (kN) = A (m^2) x P_{max} (kN/m^2)

$$t_f = \frac{V}{Q_{av}} = \frac{2V_s p_j}{P_j}$$

$$t_{close} = 0.5t_d\left[\frac{2D+5}{L_s}\right]^{1/2}$$

$$t_f = \frac{V}{Q_{av}} = \frac{2V_s p_j}{P_j}$$

$$t_{close} = 0.5t_d\left[\frac{2D+5}{L_s}\right]^{1/2}$$

$$C_{ds} = 120 + 0.36A_u$$

$$M_p = M_{po} f_{lw} f_d$$

$$X_p = \frac{P^2}{LW}$$

$$M_{pn} = 0.68L_b + 5.8N_b$$

$$M_{po} = 23 + 0.03LWx(0.9 + 0.02D)$$

$$\text{Total Bending Cost} = C_{ds} + (M_{po} + M_{pn})R$$

$$\text{Total Die Cost} = C_{ds} + (M_{po} + M_{pc} + M_{ps})R$$

$$M_{pc} = 8 + 0.6P + 3N_p$$

$$M_{ps} = KN_p + 0.4N_d$$

$$t_c = \frac{h^2_{max}}{\pi^2\alpha}\log_e\frac{4(T_i - T_m)}{\pi(T_x - T_m)}$$

$$t_r = 1 + 1.75t_d\left[\frac{2D+5}{L_s}\right]^{1/2}$$

$$C_b = 1000 + 0.45A_c h_p^{0.4}$$

$$n = \left(\frac{N_t k_1 t}{(mC_{c1})}\right)^{1/(m+1)}$$