SULIT

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

PEPERIKSAAN AKHIR
SEMESTER I
SESI 2011/2012

NAMA KURSUS	:	REKABENTUK UNTUK PEMBUATAN DAN PEMASANGAN
KOD KURSUS	:	BDD 4013
PROGRAM	:	SARJANA MUDA KEJURUTERAAN MEKANIKAL DENGAN KEPUJIAN
TARIKH PEPERIKSAAN	:	JANUARI 2012
JANGKA MASA	:	2 JAM 30 MINIT
ARAHAN	:	JAWAB **EMPAT** SOALAN SAHAJA DARIPADA LIMA SOALAN YANG DISEDIAKAN.

KERTAS SOALAN INI MENGANDUNGI SEBELAS (11) MUKA SURAT

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Q1 Design for Manufacture and Assembly (DFMA) is an approach to evaluate product design for ease of assembly and manufacture. As a newly-appointed product design engineer at Perodua Sdn Bhd, you are required to deliver a short presentation on DFMA to top management. Describe the important points and issues to be mentioned in your presentation in support of DFMA. Note-your point must be specific, direct and relevant to Perodua.

(25 marks)

Q2 (a) Describe briefly FOUR (4) basic principles of design for economical production.

(4 marks)

(b) Figure Q2 shows a bush which will be attached into a metal container. The metal container will be used for storing high temperature foodstuffs and edible chemical. The temperature range is between 200 to 400 °C. Using Table A1 (Shape Generation Capabilities of Processes), list the detail specification of the attributes for the bush. Provide a brief explanation of your selection for each attribute.

(12 marks)

(c) Using the above information in Question 2 (b) and the Boothroyd Matrix for "Compatibility between processes and materials" shown in Table A2, indicate the potential processes and materials for the manufacturer of the bush.

(5 marks)

(d) Assume that the bush will be mass manufactured, select the most appropriate process and materials to satisfy the above requirements. Provide reasons for your selection.

(4 marks)

Q3 (a) Figure Q3 (a,b,c) are components that will be assembled using automatic assembly process.

i) Determine the orientation efficiency (E) and relative cost factor (Cr);

(9 marks)

ii) Calculate the estimated feeding cost. Use the following information below:

Feeding Machine Cost RM 5000
Overhead Ratio; 1
Feeding Machine Payback Period : 30 months
No. of work shift : 2
Duration of shift per month : 5760 s

(4 marks)

(b) Briefly explain the general rules for product and parts design for efficient high speed automatic assembly.

(7 marks)

(c) Briefly explain FIVE (5) design guidelines for machining .

(5 marks)

Q4 (a) The component shown in Figure Q4 is a steel disc of 0.14% carbon with boundary conditions of $0.5 < [L/D] < 3$ where L is the length and D the diameter. Using reasonable dimensions for the disc, design the machining processes from the solid.

(15 marks)

(b) Describe the injection moulding process.

(10 marks)

Q5 (a) A batch of disc with diameter of 20 mm and thickness of 25 mm will be molded from Acetal material in order of 3 X 2 as shown in Figure Q5a. Given the percentage of runner system increased as 50 percent and the allowance value is 7.5 cm. By using Table 2 and 3 that are given;

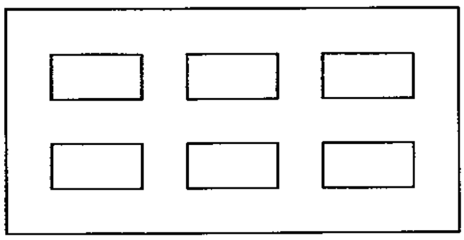

Figure Q5a

i) Determine the appropriate machine sizes.

(4 marks)

ii) Determine the cycle time.

(4 marks)

iii) Determine the mould basic cost.

(2 marks)

(b) Figure Q5b shows the rectangular shape of sheet metal with size 170mm x 90mm that surround with seven holes. The perimeter of non-standard shape for hole "L" is 80mm. 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 and bending operation to produce the part.

(15 marks)

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TABLE A1 : Shape Generation Capabilities of Processes

	Depress		UniWall	UniSect	AxisRot	RegXSec	CaptCav	Enclosed	NoDraft	PConsol	Alignmt	IntFast	
Sand casting	Y	Y	Y	Y	Y	Y	Y	N	N	4	3	1	Solidification processes
Investment casting	Y	Y	Y	Y	Y	Y	Y	N	N	5	5	2	
Die casting	Y	Y^a	Y	Y	Y	Y	N	N	N	4	5	3	
Injection molding	Y	Y^a	Y	Y	Y	Y	N^b	N	N	5	5	5	
Structural foam	Y	Y^a	Y	Y	Y	Y	N	N	N	4	4	3	
Blow molding (extr)	Y	Y^a	M	N	Y	Y	M	Y	N	3	4	3	
Blow molding (inj)	Y	Y^a	M	N	Y	Y	M	N	N	3	4	3	
Rotational molding	Y	Y^a	M	N	Y	Y	N	M	N	2	2	1	
Impact extrusion	Y	N	Y	N	Y	Y	N	N	Y	3	3	1	Bulk deformation processes
Cold heading	Y	N	Y	N	Y	Y	N	N	Y	3	3	1	
Closed die forging	Y	Y^a	Y	Y	Y	Y	N	N	N	3	2	1	
Power metal parts	Y	N	Y	Y	Y	Y	N	N	Y	3	3	1	
Hot extrusion	Y^d	N	Y	M	Y	Y	N	N	Y	2	2	3	
Rotary swaging	N^c	N	N	N	M	N^c	N	N	N	1	1	1	
Machining (from stock)	Y	Y	Y	Y	Y	Y	Y	N	Y	2	3	2	Material removal processes
ECM	Y	Y^c	Y	Y	Y	Y	N	N	N	3	4	1	
EDM	Y	Y^c	Y	Y	Y	Y	N	N	N	3	4	1	
Wire-EDM	Y^d	N	Y	Y	Y	Y	N	N	Y	2	2	3	Profile generating processes
Sheetmetal stamp/bend	Y	Y	M	Y	Y	Y	N	N	N	4	3	4	Sheet forming processes
Thermoforming	Y	Y^a	M	N	Y	Y	N	N	N	3	3	3	
Metal spinning	N	N	M	N	M	N	Y	N	N	1	1	1	

[a] Possible at higher cost.
[b] Shallow undercuts are possible without significant cost penalty.
[c] Possible with more specialized machine and tooling.
[d] Only continuous, open-ended possible.
Y, Process is capable of producing parts with this characteristic, N, Process is not capable of producing parts with this characteristic. M, Parts produced with this process must have this characteristic. An underlined entry indicates that parts using this process are easier to form with this characteristic.
The last three columns refer to DFA guidelines and are rates on a scale of 1 to 5, with 5 assigned to processes most capable of incorporating the respective guideline.

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TABLE A.2 : Compatibility between processes and materials, ■ not applicable; ☒ normal practice: and ☐ less common

Process group	Process	Cast Iron	Carbon Steel	Alloy Steel	Stainless Steel	Aluminum and Alloys	Copper and Alloys	Zinc and Alloys	Magnesium and Alloys	Titanium and Alloys	Nickel and Alloys	Refraction Metals	Thermoplastics	Thermosets
Solidification Processes	Sand Casting	☐	☐	☐	☐	☐	☐	☒	☐	☒	☐	☒	■	■
	Investment Casting	☒	☐	☐	☐	☐	☐	☒	☒	☒	☐	☒	■	■
	Die Casting	■	■	■	■	☐	☒	☐	☐	■	■	■	■	■
	Injection Molding	■	■	■	■	■	■	■	■	■	■	■	☐	☒
	Structural Foam Molding	■	■	■	■	■	■	■	■	■	■	■	☐	■
	Blow Molding (Ext.)	■	■	■	■	■	■	■	■	■	■	■	☐	■
	Blow Molding (Inj.)	■	■	■	■	■	■	■	■	■	■	■	☐	■
	Rotational Molding	■	■	■	■	■	■	■	■	■	■	■	☐	■
Bulk Deformation Processes	Impact Extrusion	■	☐	☐	☒	☐	☐	☐	☒	■	■	■	■	■
	Cold Heading	■	☐	☐	☐	☐	☐	☒	☒	■	☒	■	■	■
	Closed Die Forging	■	☐	☐	☐	☐	☐	■	☐	☐	☒	☒	■	■
	Powder Metal Parts	■	☐	☐	☐	☐	☐	■	☐	☒	☐	☒	■	■
	Hot Extrusion	■	☐	☒	☒	☐	☐	☒	☐	☒	■	■	■	■
	Rotary Swaging	■	☐	☐	☐	☐	☒	☒	☐	■	☐	■	■	■
Material Removal Processes	Machining (From Stock)	☐	☐	☐	☐	☐	☐	☐	☐	☒	☒	☒	☒	☒
	ECM	☐	☐	☐	☐	☒	☒	☒	☒	☐	☐	/	■	■
	EDM	☒	☐	☐	☐	☐	☐	☒	☒	☒	☐	☒	■	■
Profiling	Wire EDM	☒	☐	☐	☐	☐	☐	☒	☒	☒	☐	☒	■	■
Sheet Forming Processing	Sheet Metal (Stamp/bend)	■	☐	☐	☐	☐	☐	☒	☒	☒	☒	■	■	■
	Thermoforming	■	■	■	■	■	■	■	■	■	■	■	☐	■
	Metal Spinning	■	☐	☒	☐	☐	☐	☐	☒	☒	☒	☒	■	■

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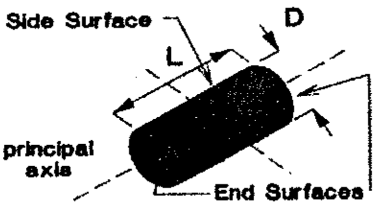
Rotational (1)	Discs $L/D < 0.8$ (2)	0
	Short Cylinders $0.8 \le L/D \le 1.5$ (2)	1
	Long Cylinders $L/D > 1.5$ (2)	2
Non-Rotational	Flat $A/B \le 3$, $A/C > 4$ (3)	6
	Long $A/B > 3$ (3)	7
	Cubic $A/B \le 3$, $A/C \le 4$ (3)	8

First digit of geometrical classification of parts for automatic handling

first digit	E	C_r
0	[illegible]	[illegible]
1	[illegible]	[illegible]
2	[illegible]	[illegible]



		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	[illegible]	[illegible]	[illegible]	[illegible]
part can be fed in a slot supported by large end or protruding flange with center of mass below supporting surfaces	1	[illegible]	[illegible]	[illegible]	[illegible]

Second and third digits of geometrical classification of parts for automatic handling

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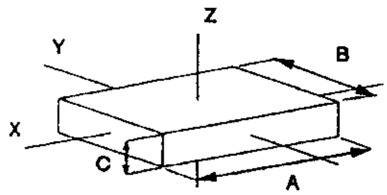

first digit	E	C_r
6	0.7	1
7	0.45	1.5
8	0.3	2

		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

Second and third digits of geometrical classification for some nonrotational parts

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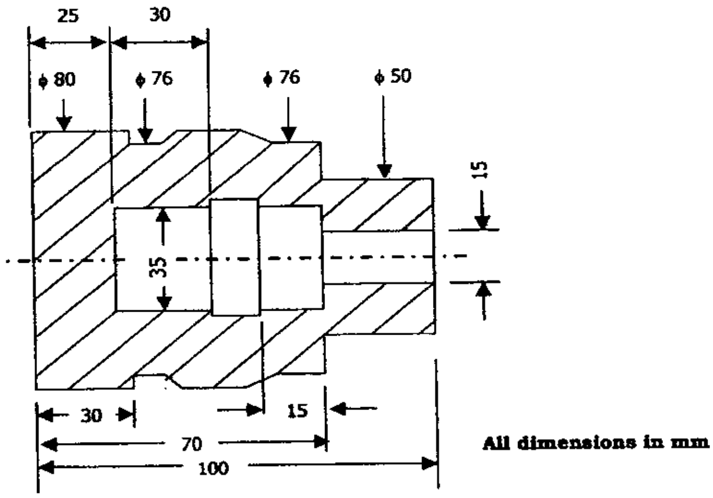
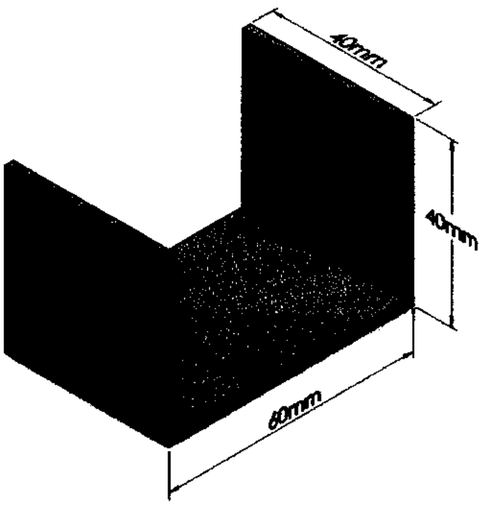
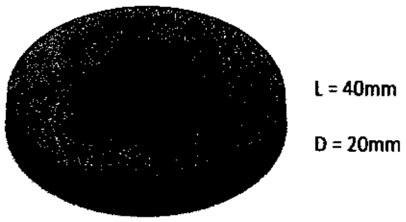


Figure Q2

a)



b)



c)

Figure Q3

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Table 2 – Injection Molding Machine

Clamping force (kN)	Shot size (cc)	Operating cost ($/h)	Dry cycle times (s)	Maximum clamp stroke (cm)	Driving power (kW)
300	34	28	1.7	20	5.5
500	85	30	1.9	23	7.5
800	201	33	3.3	32	18.5
1100	286	36	3.9	37	22.0
1600	286	41	3.6	42	22.0
5000	2290	74	6.1	70	63.0
8500	3636	108	8.6	85	90.0

Table 3 – The Processes Data for Selected Polymer

Thermoplastic	Specific gravity	Thermal diffusivity (mm^2/s)	Injection temp. (°C)	Mold temp. (°C)	Ejection temp. (°C)	Injection pressure (bars)
High-density polyethylene	0.95	0.11	232	27	52	965
High-impact polystyrene	1.59	0.09	218	27	77	965
Acrylonitrile-butadiene-styrene (ABS)	1.05	0.13	260	54	82	1000
Acetal (homopolymer)	1.42	0.09	216	93	129	1172
Polyamide (6/6 nylon)	1.13	0.10	291	91	129	1103
Polycarbonate	1.20	0.13	302	91	127	1172
Polycarbonate (30% glass)	1.43	0.13	329	102	141	1310
Modified polyphenylene oxide (PPO)	1.06	0.12	232	82	102	1034
Modified PPO (30% glass)	1.27	0.14	232	91	121	1034
Polypropylene (40% talc)	1.22	0.08	218	38	88	965
Polyester teraphthalate (30% glass)	1.56	0.17	293	104	143	1172

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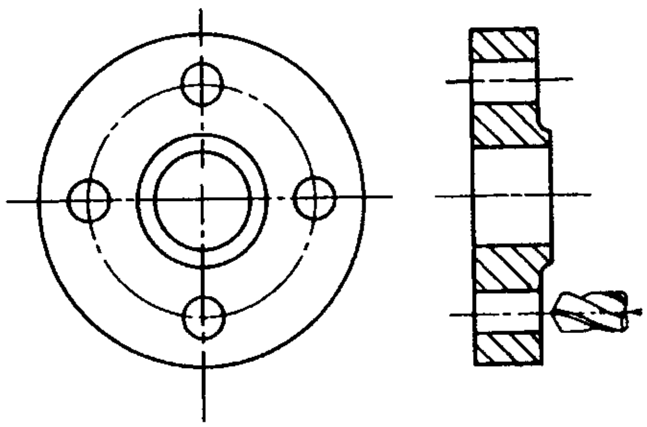

Figure Q4

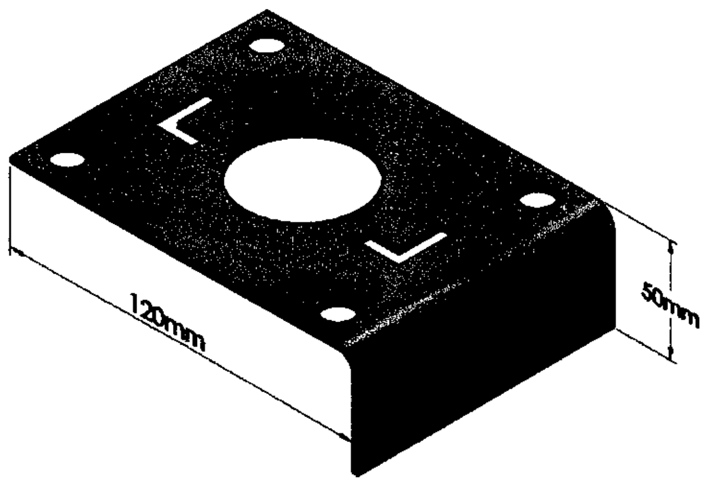

Figure Q5b

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List of Formula;

$C_f = (60/F_r)R_f$ cents

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

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

$$M_p = M_{po} f_{lw} f_d \qquad X_p = \frac{P^2}{LW}$$

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

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

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

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

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

$$M_{po} = 18 + 0.023\, LW\,(0.88 + 0.02D)$$

$$M_{po} = 23 + 0.03LW$$

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

$F\,(kN) = A\,(m^2) \times P_{max}\,(kN/m^2)$

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

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

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

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

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

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

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

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

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

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