IEEM 317 Product Design and Development **Name**
Fall 2004, Exam I
Max Time 2 Hours, Max Score: 50 **SID**

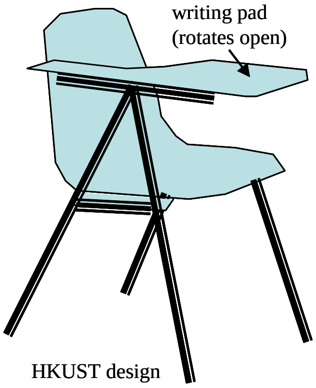
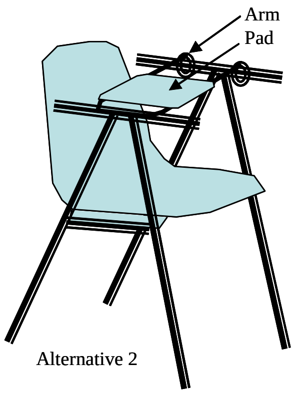
Question 1. Conceptual Design, Design evaluation [6+2+2]

(i) Given below is the sketch of a typical chair used in many classrooms in HKUST. Due to the position of the writing pad, different chairs must be used by right-handed or left-handed users.

Two alternate designs are proposed in which the same chair can be used by either right- or left-handed users. Compare the two new designs against the HKUST design using Pugh's method. For each rating you give, give a reason (1-2 lines max).

(ii) Based on your answers, which is the best design?

(iii) Write one point each for SWOT analysis of the better design among the two new ones.

 writing pad (rotates open) HKUST design	 2 writing pads (both rotate) Alternative 1	 Arm Pad Alternative 2
Pad rotates open to allow user to sit	Both pads can be opened to sit	Arm rotates to allow user to sit Pad can slide to left or right
Ease of sitting/getting up		
Manufacturing cost		
Convenience of use		
Ability to Stack-up chairs		

Question 2. Product Family Design **[4+4]**

(a) Recall that Taguchi used his "quality loss" function, $L = K(y - m)^2$, to determine the size ranges that should be offered. The 'optimal' spacing between consecutive sizes of product is such that the cost per product for the manufacturer is equal to the average loss of quality to the society.
Assume that a manufacturer uses this method to determine three consecutive size steps for a product, and these sizes are given by: s1, s2, and s3.

State TRUE or FALSE, giving your ***reason***:

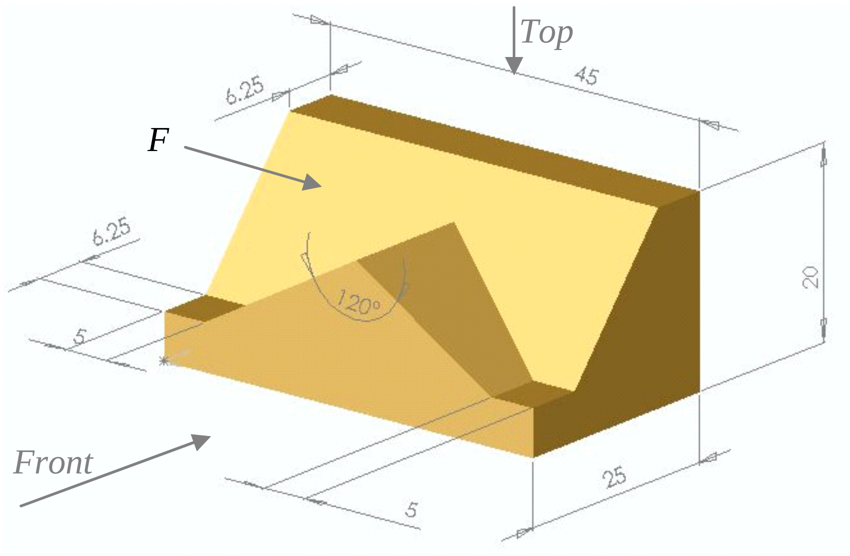
The step sizes suggested by Taguchi's method will be equal, namely, s2 – s1 = s3 – s2.

(b) Pahl and Beitz's suggestion is that consecutive step sizes should be geometrically spaced, namely, s3/s2 = s2/s1. Can this guideline be consistent with Taguchi's guideline? If not, why not? If Yes, under what conditions?

Question 3. Engineering Drawings and Projections **[(4+4)+4]**

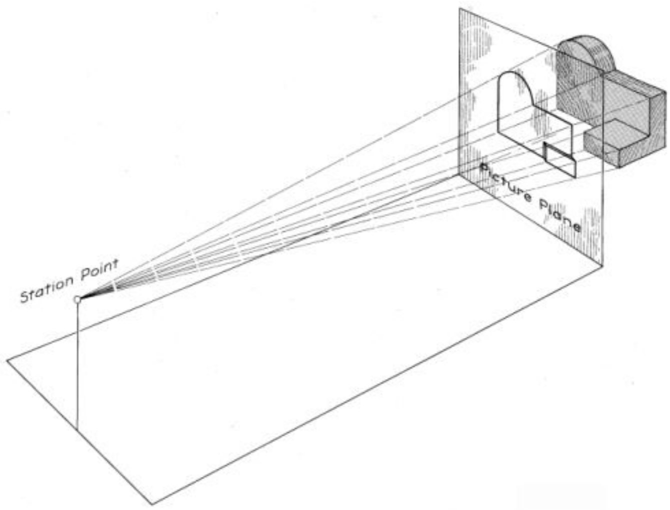
(a)

(i) The figure below shows a symmetric mechanical part (a pivot-block); draw the following three orthographic views: *TOP*, *FRONT* and *RIGHT* side.



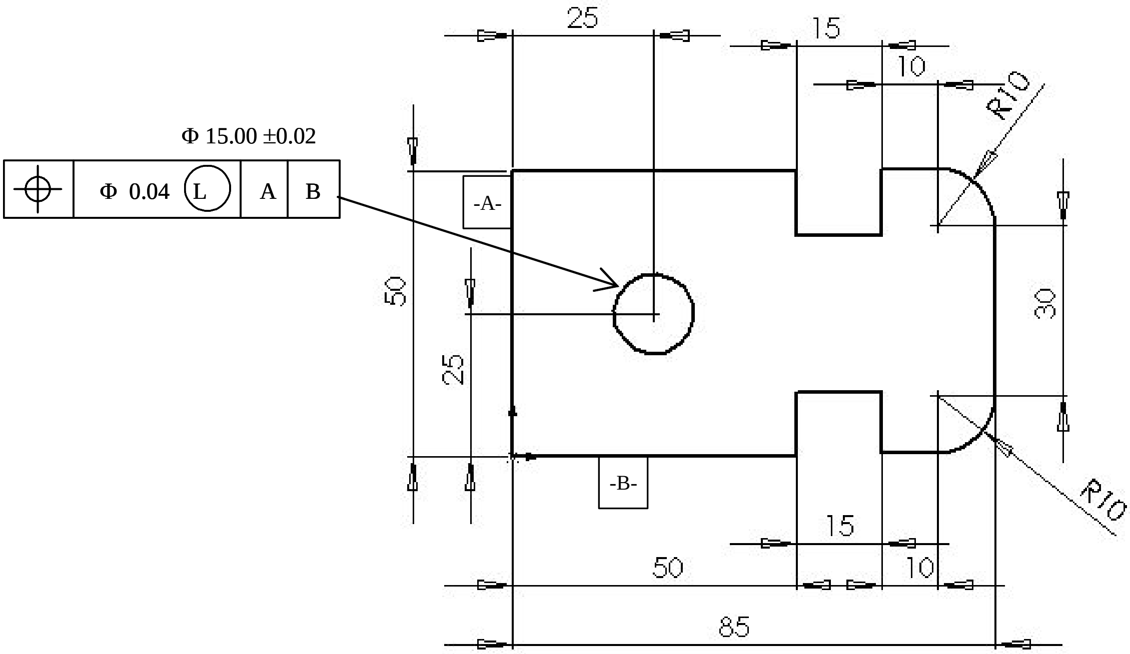
(ii) Using the orthographic views, make a projection view that shows the face marked ***F*** in true size. This view must show all faces that are visible in the *TOP* view of the part.

(b) Consider a perspective image of an object where (i) the object is completely behind (and not touching) the picture plane, and (ii) the station point (viewing point) is at a finite distance from the picture plane (see image below). Is it possible for any face of the object to appear in true size? If yes, show an example; if not, prove your answer.



Question 4. Dimensioning and Tolerancing **[(2+4+2)+(2+2)]**

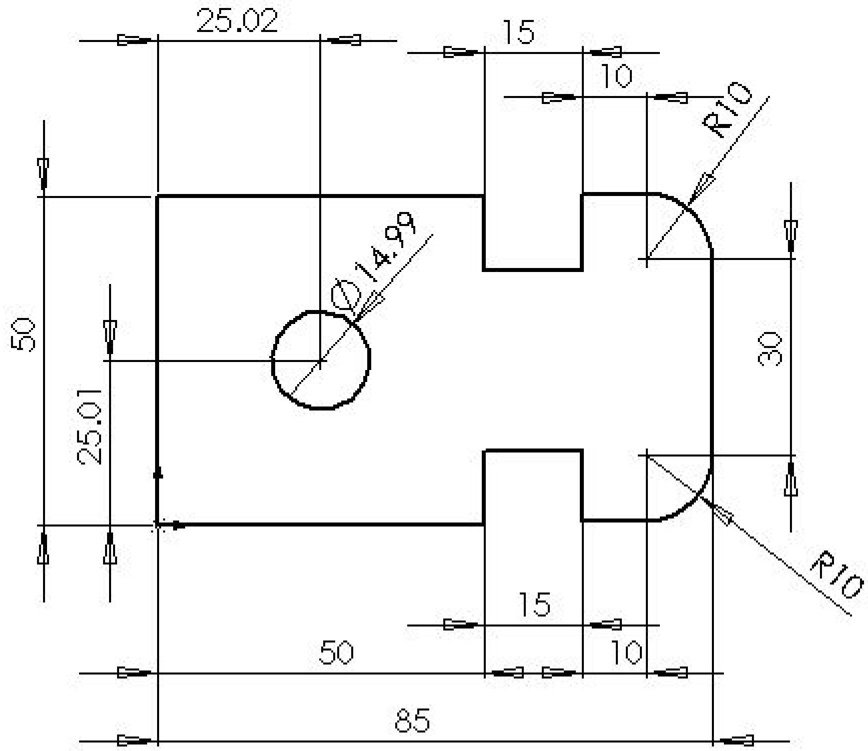
(a) The following figure shows an engineering drawing for a simple part.



(i) Among the dimensions on the drawing, identify and mark *one example* of over-dimensioning, and *one example* of under-dimensioning. Give reason for your answer (one line max, for each case).

(ii) Sketch the top view of a gauge that can be used to check the location of the hole, showing the important sizes and dimensions.

(iii) Does the hole in the part shown below meet the specifications of the drawing (give reason)?



(b) In a motorcycle engine design, the rocker-arm is connected to the piston by a pin. The pin has a nominal diameter of 12 mm, and is inserted into the hole in the piston with a shrink fit.

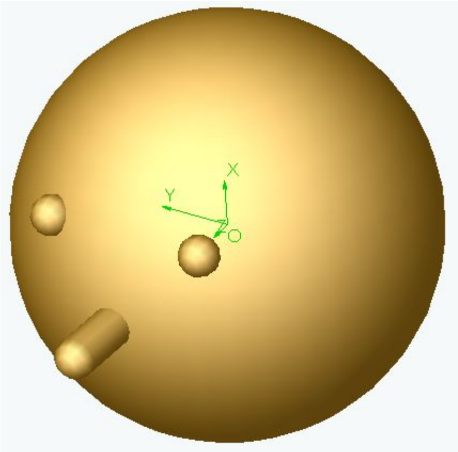
(i) What are the recommended tolerances on the hole and shaft sizes? What is the allowance for the required fit?

(ii) Using the hole basic convention, sketch the tolerance zones for the hole and shaft, clearly marking the values for tolerances and allowance.

Question 5. CAD Modeling **[8]**

For the doll-head shown in the figure below, write each step you would use to make its CAD model using Solidworks. The steps must be shown in the correct sequence, and for each step:

- If a sketch is required (or multiple sketches are required for that step), show each sketch and dimensions;
- The operation you will use, and the parameters you will need.



Geometric details for the construction:

(i) The 'head' (big sphere) is centered at the origin, with diameter = 100mm.

(ii) The 'nose' is a cylindrical surface along the Z-axis; its diameter is 10mm, and at its end is a spherical surface of diameter 10mm. The cylindrical part of the nose has a length of 15mm.

(iii) The 'eyes' are spherical surfaces with diameter 10mm; the center point of each 'eye' lies on the surface of the 'head', and is 20mm above the YZ plane, and 20mm away from the XZ plane.

Notes that may be useful

ANSI fit classification.

FIT	Sub-Type	***a*** (allowance)	***h*** (hole tolerance)	***s*** (shaft tolerance)
Clearance [easy assembly, may vibrate in use]	Loose	$0.0025d^{2/3}$	$0.0025d^{1/3}$	$0.0025d^{1/3}$
	Free	$0.0014d^{2/3}$	$0.0013d^{1/3}$	$0.0013d^{1/3}$
	Medium	$0.0009d^{2/3}$	$0.0018d^{1/3}$	$0.0018d^{1/3}$
Transition [difficult to mfg precision fit	Snug	0	$0.0006d^{1/3}$	$0.0004d^{1/3}$
	Wringing	0	$0.0006d^{1/3}$	$0.0004d^{1/3}$
Interference [difficult assembly can transmit torque]	Tight	$-0.00025d$	$0.0006d^{1/3}$	$0.0006d^{1/3}$
	Medium Force	$-0.0005d$	$0.0006d^{1/3}$	$0.0006d^{1/3}$
	Shrink	$-0.001d$	$0.0006d^{1/3}$	$0.0006d^{1/3}$

(assume that d is in mm)