THE OPEN UNIVERSITY OF SRI LANKA

FACULTY OF ENGINEERING TECHNOLOGY

DIPLOMA OF TECHNOLOGY – LEVEL 04

FINAL EXAMINATION – 2005

MEX4230 / MED2201 – PRODUCTION TECHNOLOGY

DATE : *MARCH 17, 2006*

TIME : *1015 HRS. – 1230 HRS.*

DURATION : *2 HOURS 15 MINUTES*

Answer five questions only.

Question 01

(1.1) Name and explain briefly five (5) operating characteristics that a length measuring instrument should possess.

(1.2) Figures a, b and c represents the distribution of measurements taken by three instruments when measuring the thickness of a plate.

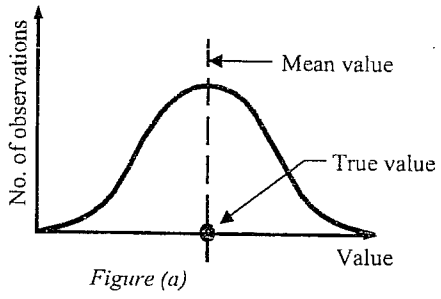


Figure (a)

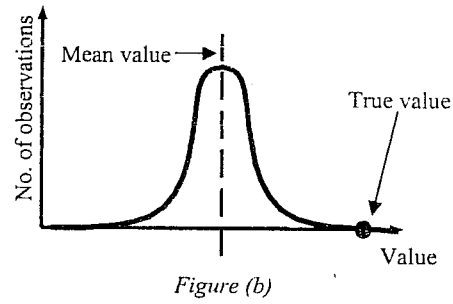


Figure (b)

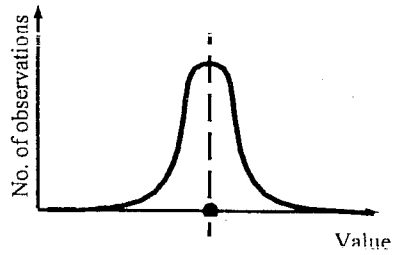


Figure (c)

(i) Comment on the accuracy and precision of the instruments used in taking the measurements. Justify your answer.

(ii) What type of errors should you minimize in order to improve the accuracy and precession?

(1.3) A customer complains that the part he purchased is not usable because of a scratch that cannot be removed by conventional polishing methods. Inspection records show that the part left the factory with a surface finish that satisfied the specified *Ra* value.

(i) Can the customer's claim be valid? If so, how?

(ii) How would you rectify the situation in future inspection procedures?

Question 02

(2.1) Explain the primary objectives of interchangeability in mass production of a particular component.

(2.2) Explain the following terms in the context of interchangeability.

(i) Universal Interchangeability

(ii) Local Interchangeability

(iii) Zero Interchangeability

(2.3) The fit of a pair of mating components is defined as 40H8/g6. Calculate the hole and shaft tolerances for the fit and present it graphically.

Use following information:

- *basic size (45 mm) lies between the nominal diameter steps of 30 mm and 50 mm.*
- *fundamental deviation for 'g' shaft is, -2.5 $D^{0.34}$ (D is the geometrical means of the diameter steps in millimeters).*
- *Tolerance unit (t) is given as, $i = 0.45\sqrt[3]{D} + 0.001 D$ in microns.*
- *Values of standard tolerances correspond to grades 5 to 16 are:*

Tol.Grade	IT 5	IT 6	IT 7	IT 8	IT 9	IT 10	IT 11	IT 12	IT 13	IT 14	IT 15	IT 16
Values	7i	10i	16i	25i	40i	64i	100i	160i	250i	400i	640i	1000i

Question 03

(3.1) Explain the critical velocities in analyzing mechanics of metal cutting.

(3.2) Using the idealized chip formation model, obtain an expression relating the above velocities in terms of shear angle, rake angle and friction angle.

(3.3) By using the relationship obtained in (3.2) or otherwise, show that the ratio between the chip velocity to cutting velocity gives the cutting ratio.

Question 04

(4.1) Explain two dimensional and three dimensional cutting techniques, with aid of neatly drawn sketches. Also state the basis on which this classification is made.

(4.2) The cutting force for the ideal-chip formation model is given by the expression,

$$F_c = \tau_s A_c \left[\frac{\cos(\beta - \gamma)}{\cos\{\phi + (\beta - \gamma)\}\sin\phi} \right]$$ where,

F_c – cutting force

τ - shear strength of the work-piece material

A_c - area of uncut chip

β - friction angle on the tool face

γ - rake angle of the tool

ϕ - angle of shear

By using the above expression, obtain a mathematical relationship for the Merchants law of metal cutting.

(4.3) Explain the consequence of,

(i) Having a larger rake angle.

(ii) Increased friction angle for a given rake angle,

On the chip contraction ratio and the cutting force. You may use the expression obtained in (4.2) to justify your answer.

Question 05

(5.1) Explain briefly the main zones in which heat is generated during metal cutting processes. Represent these zones on a diagram.

(5.2) Obtain an expression for the heat generated on the shear plane in terms of cutting velocity, shear angle, feed force and friction force between chip and tool, for a cutting operation having zero rake angle in the absence of built-up-edge. State any assumptions you make. [Hint: Heat generated in a cutting operation = power consumed in the cutting operation /mechanical equivalent of heat (J).]

(5.3) (i) Define "tool life".

(ii) By using the Taylor's relationship for tool life, discuss the effect of cutting speed on the material removal.

(iii) What are economical implications of above (ii).

Question 06

(6.1) "In metal deformation processes, engineering stress and strain are of secondary importance".

In view of the above, describe the important stresses and stains in metal deformation processes.

(6.2) Describe the phenomenon of cold working and hot working and discuss their effects on strength and ductility of the material. Give examples for hot and cold deformation processes.

(6.3) Explain the law obeyed in cold working and hot working, naming all parameters in the expressions.

Question 07

(7.1) Spring-back is an effect encountered in most deformation processes especially in bending.

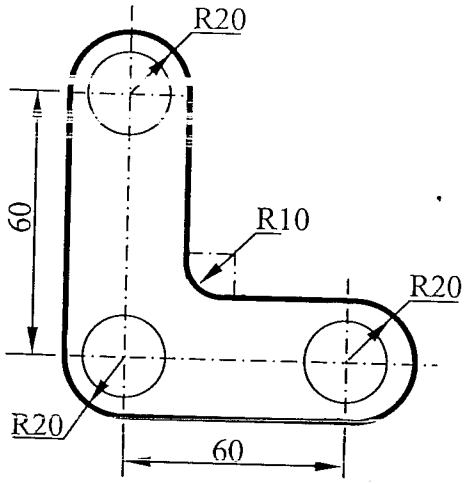
(i) Explain the phenomenon of spring-back.

(ii) Under what criteria does this effect tend to increase?

(iii) Briefly explain the way in which spring-back can be minimized.

(7.2) Explain the types of dies used for blanking in mass production.

(7.3) Calculate the blanking and punching forces separately to produce the part shown in Fig. (Q7). Thickness of the part is 5mm, and ultimate tensile strength (UTS) of the metal is 1000N/mm^2. The punched holes are of same size having a diameter of 20mm each. Assume all the holes are punched simultaneously. The shear strength of the metal is 60% of the UTS.



All Dimensions in mm

Not to scale

Figure Q7

Question 08

(8.1) Explain the means by which productivity can be increased in a machine tool.

(8.2) Explain the types of machine tools based on the degree of accuracy.

(8.3) Name at least five factors which has to be taken into consideration when selecting an appropriate drive for a machine tool

(8.4) Explain with an aid of a numerical example why geometric progression is preferred over arithmetic progression when arranging spindle speeds in machine tools.