TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATIONS FOR DEGREE IN BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

(BSME) Y5-S2

EMG 2523: MECHANICS OF METAL CUTTING

END OF SEMESTER EXAMINATIONS

SERIES: MAY 2016

TIME: 2 HOURS

INSTRUCTIONS:

- You should have; Answer booklet,; Drawing instruments and Scientific calculator
- This paper consists of FIVE questions
- Attempt any THREE questions.

This paper consists of THREE printed pages

QUESTION 1

a) (i) State THREE indicators of tool failure (1.5 marks)
(ii) State FOUR characteristics of orthogonal as opposed to oblique cutting (2 marks)
(iii) Working from first principles, establish Merchant's shear angle expression (3 marks)

b) In an orthogonal cutting experiment:
Chip thickness after cutting……..= 2.0mm
Coefficient of friction……..=0.9
Width of cut……= 10mm
Feed…… = 1.25mm/rev
Rake angle……= 10^o
Shear strength…… …= 6000kg/cm^2
Cutting speed……= 30m/min
Determine, by way of Merchant's theory:
i) The shear plane angle Ø
ii) The friction angle
iii) The cutting force
iv) H.P of motor of mechanical η = 0.95 *(13.5 marks)*

QUESTION 2

a) Working from first principles, establish the optimum cutting speed V_T where the total cost of machining a batch is a minimum. (12 marks)

b) (i) In a certain machining operation on a component, n = 0.25, C = 150, tool change time = 8 minutes, tool regrind time = 5 minutes, machine running cost =£2.00 per hour, depreciation of tool per regrind = £0.125. Calculate the optimum cutting speed. (3 marks)

(ii) If 1000 components are required with a machine length of 100mm at 65mm diameter using a feed of 0.2mm/rev, calculate the time required to machine the batch of 1000, and the total cost Y_T (5 marks)

QUESTION3

a) With the aid of sketches, describe the circumstances that favour the formation of the following types of chips:

(i) Discontinuos chip
(ii) Continuous chip
(iii) Continuous chip with chip welding (6 marks)

(b) Discuss briefly the following cutting fluids:

(i) Solid lubricants
(ii) Emulsions
(iii) Chemical solutions
(iv) Straight fatty oils
(v) Aqueous solutions (10 marks)

(c) The power to cut a material under certain conditions is 2.6 W/mm^3/s. A cut 5.2 mm deep x 0.22mm/rev feed is taken at a cutting speed of 18 m.p.m and the work cooled by a flow of 3.5 litres of coolant per minute, specific heat capacity 3.6 kJ/kg ^{o}C, which conducts away 82% of the heat. The specific gravity of the coolant is 0.92. Determine the rise in temperature of the coolant due to this cut. (4 marks).

QUESTION4

a) Discuss vibration and chatter on machine tools (3 marks)

b) In a machining operation the cutting force F_C is related to the depth of cut (d) and feed (f) by the expression:

$F_C = 1958\ d^{0.88}f^{0.65}$

A lathe,under such conditions, consumes 5.5kW on a workpiece of diameter 125mm, depth of cut 4.5mm and feed 0.2mm/rev. Determine the maximum spindle speed (R.P.M)(6 marks).

c) In an orthogonal cutting process, the cutting velocity was 13m/minute and the forces normal to the shear plane (F_{NS}) are 1400N. If the rake angle was 10^o, chip thickness ratio 0.35 and the coefficient of friction was 1.2, determine the motor horsepower if the efficiency is 0.9 (6 marks)

d) An end mill cutter of diameter 120mm is to face mill a workpiece 100mm wide. The optimum power available is 4 kW, depth of cut is 3mm, cutting speed is 22m/minute and the cutter has

16teeth. If the material removal rate (K) is 25,000mm^3/(min.kW), determine the feed rate per tooth. (5 marks)

QUESTION5

a) With the aid of a sketch, describe the principle of the cutting tool dynamometer (7 marks)

b) In an orthogonal cutting experiment the cutting force was 201N, feed force 120N, rake angle 28^o and chip thickness ratio $\frac{2}{5}$. If the cutting speed was 25 m.p.m, determine the friction work at the tool rake face. (6 marks)

c) Define the following terms:
   i) waviness
   ii) roughness
   iii) Errors of form (3 marks)

d) Fig 1 shows the area trace in a roughness test with the attendant magnification. Calculate R_a value for the surface in micrometers. (4 marks)

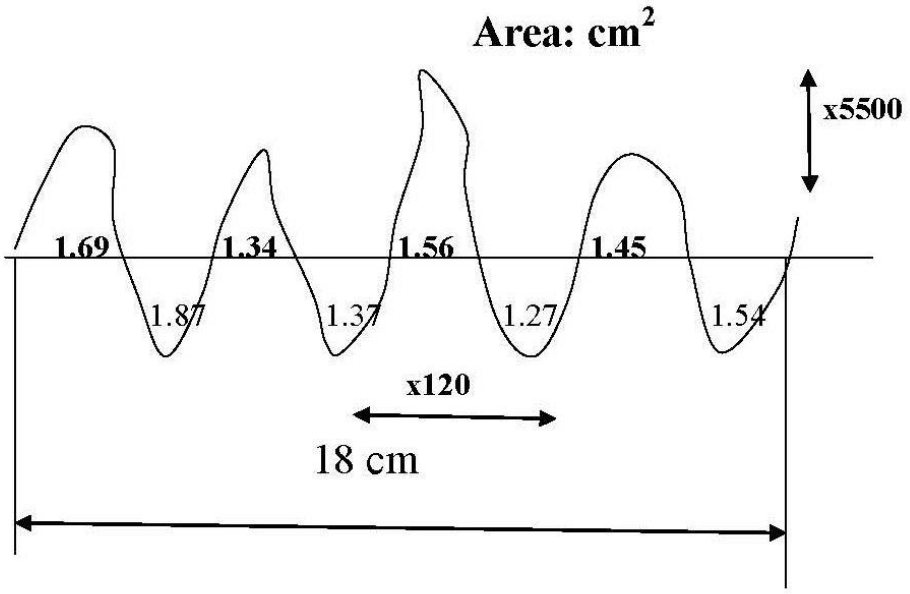

FIGURE 1