TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATION 2013/2014

FIFTH YEAR SECOND SEMESTER UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2523 : MECHANICS OF METAL CUTTING

TIME: 2 HOURS **SERIES:** DECEMBER, 2013

INSTRUCTIONS TO CANDIDATES

1. You are required to have the following for these examinations:
   - Drawing Instruments
   - Scientific Calculator

2. This paper has **FIVE** Questions.
3. Answer **ANY THREE** Questions.
4. All Questions carry **EQUAL** marks.
5. This paper consists of **FOUR** ***Printed pages.***

QUESTION 1

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

(b) In a certain machining operation on a components, n = 0.25, C = 183, tool change time = 8 min, tool regrind time = 6 minutes, machine running cost = Sh.200 per hour; deprecation of tool per regrind = Sh.12. Calculate the optimum cutting speed. **(3 marks)**

(c) If 3000 components are required with a machined length of 125mm at 65mm diameter using a feed of 0.2mm/revolution, calculate the time required to machine the batch of 3,000, and the total cost Y_T. **(5 marks)**

QUESTION 2

In an orthogonal cutting set up, the depth of cut was 10mm, feed = 1mm/rev, cutting speed = 60 m.p.m, bac, rake angle = 10°, chip thickness ratio = 0.33, shear stress of material at zero compressive stress = 1000kg/sq-cm. Assume that value of constant k in equation $2\phi + \beta - \alpha = \cot^{-1} k$ is 0.2. Calculate the resultant force, rate of metal removal, shear strain, h.p at the tool per cubic cm of metal removal per minute. Take $\psi = \psi_o / \{1 - k \tan(\phi + \beta - \alpha)\}$

(20 marks)

QUESTION 3

(a) Discuss vibration and chatter on machine tools. **(2 marks)**

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

$F_c = 1950 d^{0.84} f^{0.6}$

A lathe under such conditions consumes 5.5kW on a workpiece of diameter 150mm, depth of cut 4.5mm and feed 0.41mm/rev. Determine the maximum spindle speed (R.P.M).

(6 marks)

(c) In an orthogonal cutting process, the cutting velocity was 12.2mpm and FNs is 1100N. If the rake angle was 12.5°, chip thickness ratio = 0.4 and the coefficient of friction was 1.16, determine the motor horsepower if the efficiency is 0.85. **(6 marks)**

(d) An end will cutter of diameter 120mm is to face mill a workpiece 90mm wide. The optimum power available is 6kw, depth of cut is 4.5mm, cutting speed = 20mpm and the cutter has 20 teeth. If the material removal rate (k) is 21,000mm^3/(min.kW), determine the feed rate per tooth. **(6 marks)**

QUESTION 4

(a) The power to cut a material under certain conditions is 2.1W/mm^3/S. A cut 6mm deep x 0.23mm/rev feed is taken at 22.5m/min and the work is cooled by a flow of 2.5 litres of coolant per minute, of specific gravity 0.92 and specific gravity 0.92 and specific heat capacity 3.5kJ/kg^{o}C. This coolant conducts away 90% of the heat. Determine the rise in temperature of the coolant. **(4 marks)**

(b) Discuss briefly the following cutting fluids:

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

(10 marks)

(c) (i) Describe, tool:

(I) Face wear
(II) Flank wear

(ii) Explain how flank wear determines too life. **(6 marks)**

QUESTION 5

(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 195N, feed force 130N, rake angle 20^o and chip thickness ratio 0.35. If the cutting speed was 26m.pm, determine the friction work at the tool rake face. **(7 marks)**

(c) Define the following terms:
(i) Errors of form
(ii) Roughness
(iii) Waviness

(3 marks)

(d) Figure 1 shows the area trace in a roughness test with the attendant magnification. Calculate Ra value for the surface in micrometers. **(3 marks)**