THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

MEC 3102 PRODUCTION TECHNOLOGY AND ELECTRICITY & ELECTRONICS II

ASSIGNMENT NO 1. – THEORY OF METAL MACHINING

Submit ALL EIGHT (8) Questions

DUE DATE: 12th October 2022

(NB: Marks will be deducted for not showing your work)

Q1. In a turning operation, cutting speed = 1.8 m/s. Feed = 0.30 mm/rev and depth of cut = 2.6 mm. Rake angle = 8°. After the cut, the deformed chip thickness = 0.56 mm.

Determine:

(a) Shear plane angle,

(b) Shear strain,

(c) Material removal rate.

Use the orthogonal cutting model as an approximation of the turning process.

Q2. The cutting force and thrust force in an orthogonal cutting operation are 1470 N and 1589 N, respectively. Rake angle = 5°, width of the cut = 5.0 mm, chip thickness before the cut = 0.6, and chip thickness ratio = 0.38.

Determine:

(a) The shear strength of the work material, (b) The coefficient of friction in the operation.

Q3 In an orthogonal cutting operation, the rake angle = -5°, chip thickness before the cut = 0.2 mm, and width of cut = 4.0 mm. The chip ratio = 0.4.

Determine:

(a) The chip thickness after the cut,

(b) Shear angle,

(c) Friction angle,

(d) Coefficient of friction, and

(e) Shear strain.

Q4 In a turning operation, cutting speed = 200 m/min, feed = 0.25 mm/rev, and depth of cut = 4.00 mm. Thermal diffusivity of the work material = 20 mm^2/s and volumetric specific heat = 3.5 (10^{-3}) J/mm^3-C. If the temperature increase above ambient temperature (20°F) is measured by a tool-chip thermocouple to be 700°C, determine the specific energy for the work material in this operation.

Q5 Orthogonal cutting is performed on a metal whose mass specific heat = 1.0 J/g-C, density = 2.9 g/cm^3, and thermal diffusivity = 0.8 cm^2/s. Cutting speed = 3.5 m/s, uncut chip thickness = 0.25 mm, and width of cut = 2.2 mm. Cutting force = 950 N. Determine the cutting temperature if the ambient temperature = 22°C.

Q6. The following data were obtained from a cutting test: γ = 20°, k = 90, depth of cut 6.4 mm, feed 0.25 mm/rev, chip length before cutting 29.4 mm, chip length after cutting 12.9 mm. The cutting forces were axial force 427 N, vertical force 1050 N.

Use Merchant's analysis to calculate:

(a) The direction and magnitude of the resultant force;

(b) The shear plane angle;

(c) The frictional force; (d) the friction angle.

Q7 The following data were obtained from a cutting test: γ = 20°, k = 90, depth of cut 6.4 mm, feed 0.25 mm/rev, chip length before cutting 29.4 mm, chip length after cutting 12.9 mm. The cutting forces were axial force 427 N, vertical force 1050 N.

Use Merchant's analysis to calculate:

(a) The direction and magnitude of the resultant force;

(b) The shear plane angle;

(c) The frictional force;

(d) The friction angle.

Q8. (a) Determine Merchant's constant *C* for aluminium from the following information:

γ = 35°, F_c = 200 N; F_a= 90 N; t_1 = 0.125 mm; t_2 = 0.25 mm; cutting speed = 30 m/mm; width of cut = 2.5 mm.

(b) What amount of work per minute is done against friction at the chip-tool interface?

Dr. Vincent MUSONDA **30th September 2022**