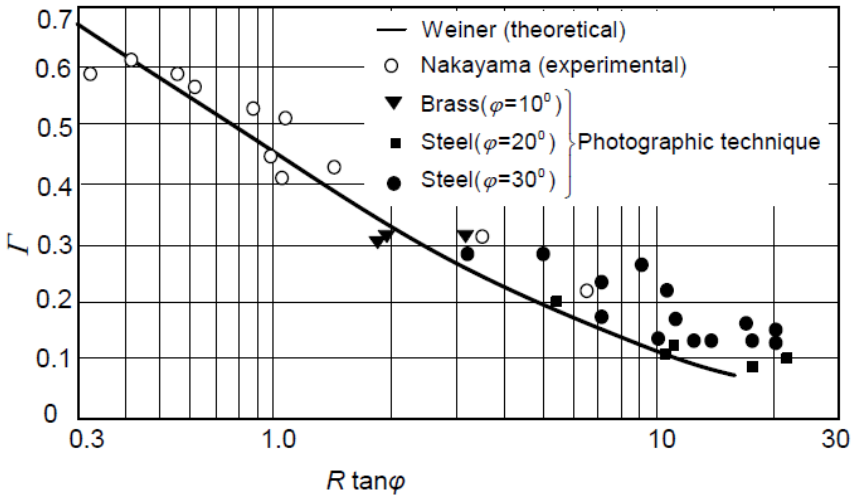
ME58120320 HW#3

Due: July 10th (Wednesday) at 8:00 AM before lecture

Ch9: Temperature

1. The maximum temperature along the tool face and the temperature on the newly machined surface are to be estimated for the following condition during the turning of carbon steel at a room temperature of 22°C. (26 points)
Rake angle α = 5 deg
Cutting force F_P = 415 N
Thrust force F_Q = 80 N
Cutting speed v = 1 m/s
Undeformed chip thickness t = 0.5 mm 11
Width of cut b = 1 mm
Cutting ratio r = 0.67
Length of contact between chip and tool face l_f = 0.08 mm
Width of secondary deformation zone under unlubricated condition w_o = 0.2
Alloy steel density ρ = 7250 kg/m3
Alloy steel thermal conductivity k = 400 W/mK
Alloy steel specific heat capacity c = 500 J/kgK



** For very large Rtanϕ, Γ can be estimated to be zero, that is, all the heat is transferred to the chip*

Figure 1.

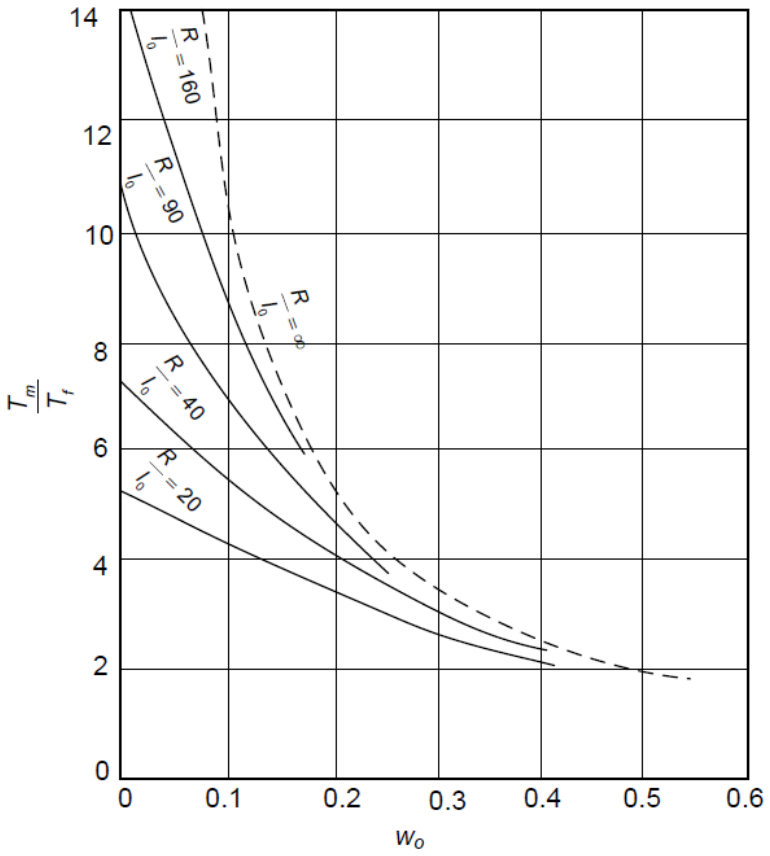


Figure 2.

Ch11: EDM

1. An experimental study is conducted to compare EDM performance between RC circuit and transistor-based generator under the same individual pulse discharge energy (E_d) and cycle frequency of 6.25 kHz. The workpiece is hardened steel and the DC power supply is 240 V.
(1) In transistor-based generator, the duty factor is set 0.5 and the measured discharge voltage and current are 30 V and 80 A, respectively. What is the individual pulse discharge energy (E_d)? (3 points)
(2) With the same E_d in (1), what R and C values should be used in RC generator to maximize the material removal? (given that $u_e = 0.73u_o$ and $t_e = 0.1t_c$ for maximum productivity). (8 points)

2. For an EDM machine with transistor circuit generator, if average cycle voltage $\bar{u}$ = 50 V when discharge time t_e= 120 μs and interval time t_o= 30 μs. It is known that discharge current i_e= 60 A, open voltage u_o= 150 V and discharge voltage u_e= 25 V.
For an ideal condition of isopulse series to calculate:
(1) Discharge delay time (t_d). (4 points)

(2) Cycle frequency (f_r). (4 points)
(3) Duty factor. (3 points)

Ch12: ECM

1. A weight reducing process will be conducted to machine a titanium (atomic weight 47.9 g, density 0.00452 g/mm^3 and valence is 3) workpiece with surface area of 2500 mm^2 using an ECM machine. This ECM machine provides voltage of 20 volts and can afford current up to 5000 amp. The electrolyte used in this machine has electrical conductivity of 20 (S·m^{-1}).
(a) What is the smallest possible gap distance? (6 points)
(b) How long does it take to reduce weight by 50 g? (8 points)

Ch13:Laser and E-beam Machining

1. A pulsed laser beam machine is used to drill microholes on Zirconium (vaporization energy 42.5 J/mm3). This machine generates laser pulses with 1.5 J/pulse energy and 0.001 s pulse duration. The beam divergence of the laser is 0.002 rad, and its radiation is focused with a 30mm focal length lens. Suppose the conversion efficiency of input energy to thermal energy is 0.5%, which corresponds to material removal. How many pulses are needed to drill a 1 mm deep hole? (15 points)

2. List the material removal mechanisms, advantages and disadvantages of EDM, ECM, CHM, LBM, and EBM. (15 points)

3. Compare EDM and ECM in terms of the polarity of the workpiece, level of voltage and current, the electrical conductivity of the electrolyte, and the machined surface quality. (8 points)