GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Spring Quarter 1999

Manufacturing
EXAM AREA

Assigned Number (DO NOT SIGN YOUR NAME)

- **Please sign your name on the back of this page—**

Please **p r I n t** your name here.

The Exam Committee will get a copy of this exam and will not be no i.
whose paper it is until it is gra ed.

Note: Answer five, and not more than five, of the following q estions:

1. A 50.8 mm diameter cylindrical bar of mild steel is being tu ed on a lathe as sh v schematically in the figure below.

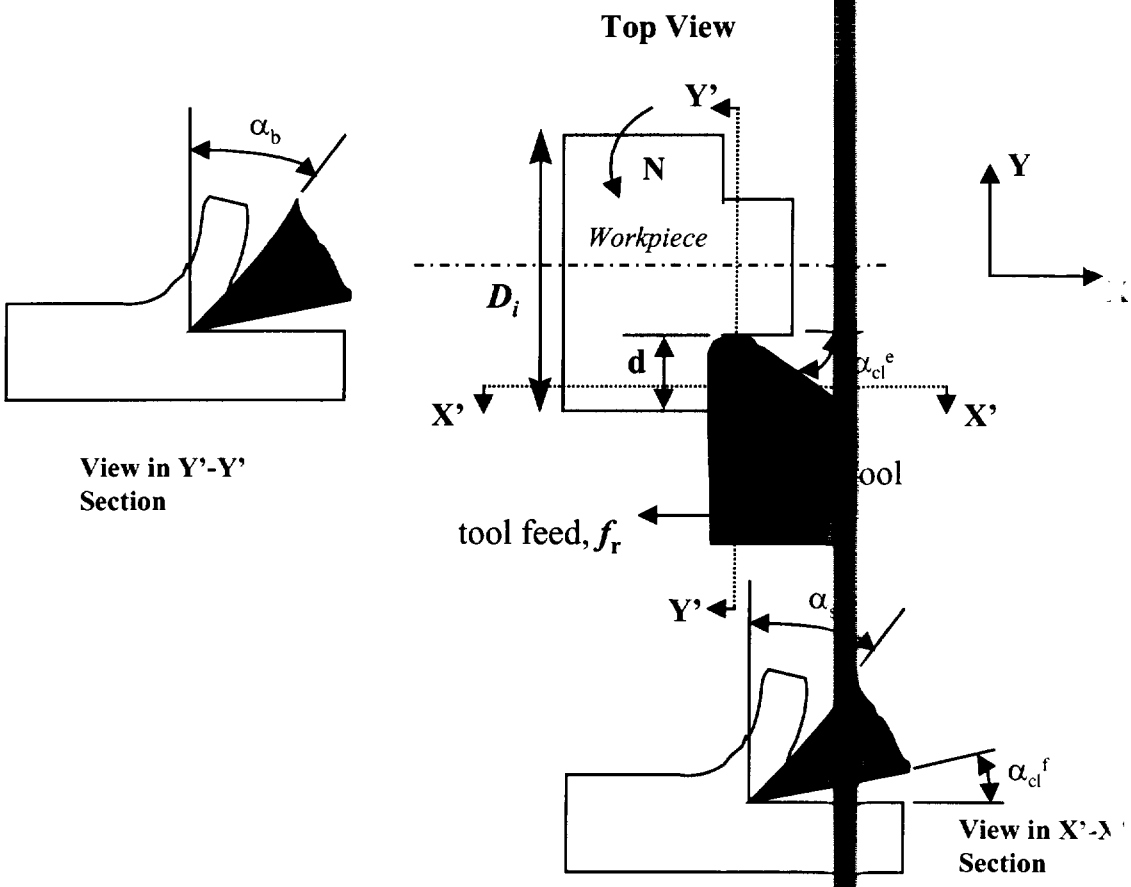

Figure. Top view of the cutting operati .

The cutting tool is made of TiN coated carbide and has the f lowing geometry: b k rake angle α_b = 0 deg, side rake angle α_s = +5 deg, end clear ce angle α_{cl}^e and fl r clearance angle α_{cl}^f = 7 deg each, and nose radius r_n = 2 mm (see figure f definition of all angles). The cutting conditions used are as llows: spindle spee l = 752 rpm, depth of cut d = 2.5 mm, feed per revolution f_r 0.25 mm, and cut i ratio r_c = 0.3. No cutting fluids are used. Experimental m surements of the t c chip contact length, l_f, yields a value of 0.75 mm. Also, l force measurem n made with a force dynamometer yield the following values: = 650 N, F_y = -1(N F_z = -900 N. Note that the negative sign for the force compo nts indicate their se relative to the tool coordinate system shown.

Given that 10% of the power dissipated in the shear zo is conducted into t workpiece, estimate the mean temperature rise in the chip. Clearly state and justi (in itemized form) all assumptions you make in arriving at y r answer. The speci heat capacity, c, and density, ρ, of the mild steel material e 500 J/KgK and 7 Kg/m^3, respectively.

2. You are given four cutting tool materials: high speed steel, oated carbide, ceram and polycrystalline diamond. Discuss the suitability of ea h tool material for th following machining operations from the standpoint of too life and economics rough machining of a AISI 1020 steel bar, annealed, of cons nt diameter throughou its length, *b)* finish machining of a AISI 1070 bar of constan diameter throughou length, heat treated to a hardness of 60 on the Rockwell C s le, *c)* finish machini of a AISI 1070 bar with interruptions in diameter throughout s length, heat treate the same hardness as in (b), and *d)* rough machining of a niform diameter ba aluminum 390 alloy with high silicon content. Assume tha in each case turnin the cutting operation to be used. Use scientific reasoning to xplain why a given o material is suitable/unsuitable for the specified machining op ation.

3. Give the names and describe the microstructure of the diff ent types of cast ir Compare and contrast their mechanical properties.

4. Describe each step involved in investment casting. What o r name is common t this casting process? What are the characteristics (advantag s and disadvantages investment casting versus other casting processes?

5. Calculate the force required in direct extrusion of 707 O aluminum (stre g coefficient = 400 MPa and strain-hardening exponent = 0.17 rom a diameter of to 2 in. Assume that the redundant work is 40% of the ideal ork of deformation that the friction work is 25% of the total work of deformation

6. Open die forging is to be carried out on cylindrical workpie s with a cross-sectio area of 220 mm^2 and a height of 20 mm. The workpieces w be forged to either mm or 18 mm high depending on the application. The m imum force neede forge the workpiece to 18 mm is 75% of that needed to fo e the workpiece to mm. What is the ratio of work needed to forge to 18 mm a to 16 mm? You assume that the friction at die-workpiece interface is negligib