PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Final Examination: Semester II — Academic Year: 2006

Date: February 28, 2007 — Time: 13:30-16:30

Subject: 226-308 Modern Manufacturing Processes — Room: A400

Instructions

- Write your answer in this paper exam only, show your work clearly and legibly.
- Write your name and student ID on every page of the paper exam and A4 and **submit all materials**.
- Double sides of A4, dictionary, and calculator are allowed.
- There are 6 problems and total score is 115.
- Carefully read the problems and answer all questions in each problem.

ทุจริตในการสอบ โทษขั้นต่ำ คือ พักการเรียน 1 ภาคการศึกษา และปรับตกในรายวิชาที่ทุจริต

Name ..... **Student ID** .....

Question #	Full Score	Assigned Score
1	20	
2	20	
3	15	
4	20	
5	20	
6	20	
Total	115	

Good Luck

Thanate Ratanawilai

Student ID .....

Problem 1. (20 points)

1.1 Tool life can be almost infinite at low cutting speeds. Would you recommend that all machining be done at low speeds? Explain any limitations on doing so.

1.2 Why does temperature have such an important effect on the life of cutting tools?

1.3 What is maximum cutting speed when using Carbon steel cutting tool? (5 , 50, 100, or 150 m/min)

1.4 Why should not apply cutting fluid when using Cubic Boron Nitride (CBN)?

1.5 What is an advantage of Polycrystalline diamond?

1.6 What is the difference between infra cermets and ultra cermets?

1.7 The ceramic tool is frequently broken, how to prevent?

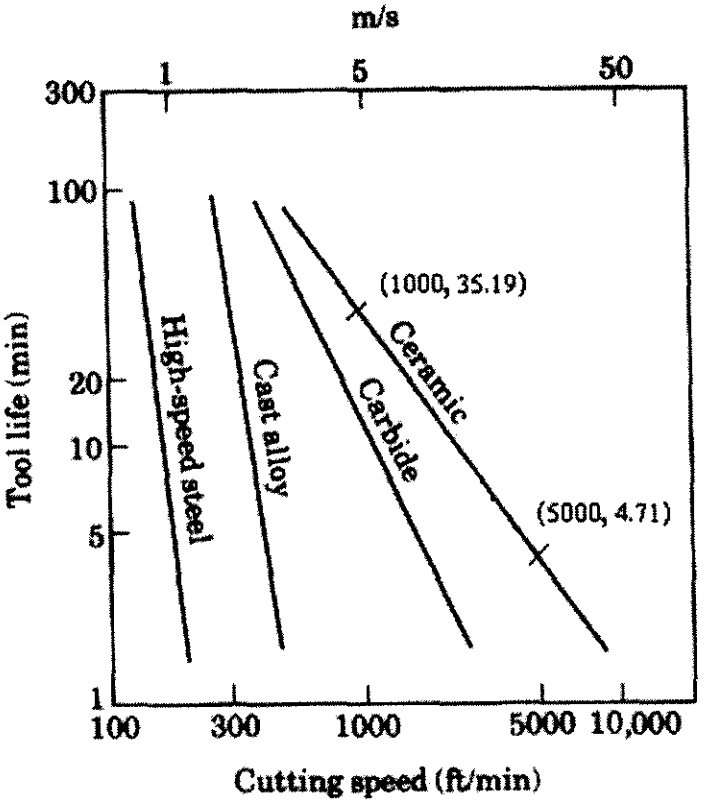
1.8 What is the effect of filling Cobalt into HSS?

1.9 Which of the two materials, diamond or cubic boron nitride, is more suitable for cutting steels? Why?

1.10 Why the maximum temperature in cutting is located at about the middle of the tool-chip interface?

Problem 2. (20 points)

2.1 Determine the n and C values for the ceramic tool materials shown in the following figure.



2.2 Based on the tool life equation in Problem 2.1, what is the percent increase in tool life if the cutting speed is reduced by 20%.

Problem 3. (15 points) A 6 in. long, 0.5 in. diameter 304 stainless steel rod is being reduced in diameter to 0.480 in. by turning with a single pass on a lathe. The spindle rotates at 400 rpm, and the tool is traveling at an axial speed of 8 in./min. Calculate

3.1 the cutting speed

3.2 material removal rate (the volume of material remove per unit time)

3.3 time of cut

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Problem 4. (20 points) A chip-breaker height and a chip breaker distance of an integral obstruction-type chip breaker are 1 mm and 4 mm, respectively. When the chip thickness is 0.8 mm, the chip is broken satisfactorily. If the chip-breaker height of an attached obstruction-type chip breaker is 2 mm and the chip breaker wedge angle is 45°, what chip-breaker distance should be provided for to give the same performance as the integral obstruction-type chip breaker? (Assume that the chip-tool contact length is equal to the chip thickness.)

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Problem 5. (20 points)

5.1 When cutting metal orthogonally with a tool of zero rake angle, show that the mean coefficient of friction on the tool face, μ, is given by

$$\mu = \frac{1}{r_c}\left(1 - \frac{P_s}{F_c v}\right)$$

Where

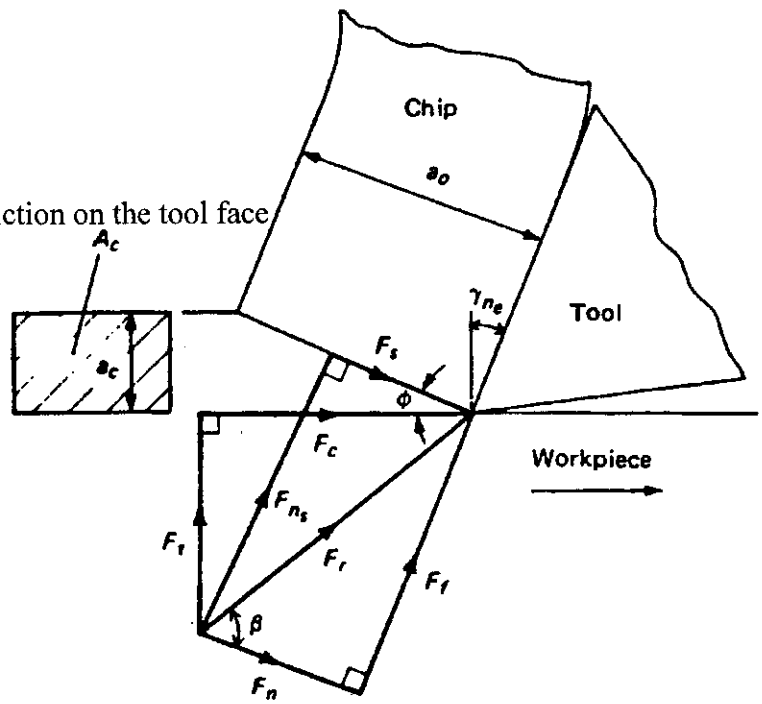
F_c = cutting force

V = cutting speed

μ = mean coefficient of friction on the tool face

= tan β

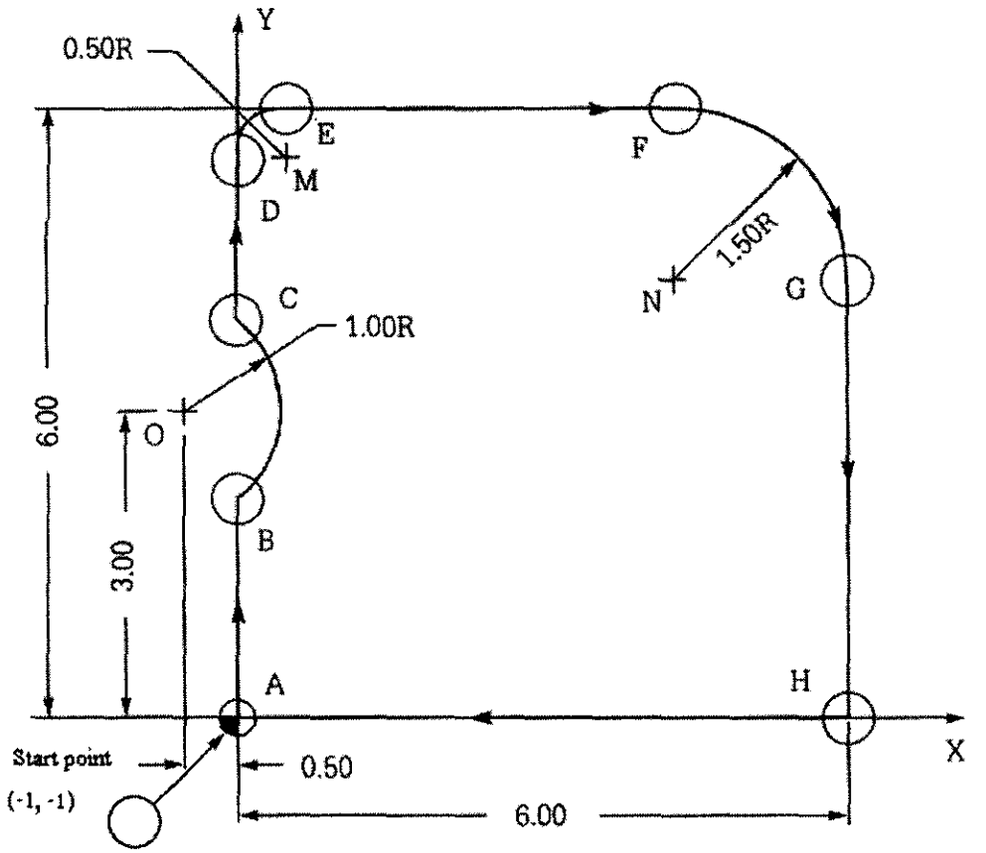
R_c = cutting ratio



5.2 Calculate the mean shear-zone temperature rise θ_s when the metal has a specific cutting energy of 2.5 GN/m^2, $\mu = 1.0$, $r_c = 0.2$, and 15 percent of the shear zone heat is conducted into the workpiece. Let specific heat capacity = 500 J/kgK and density = 7000 kg/m^3.

Student ID .....

Problem 6. (20 points) Complete a CNC program to profile mill the contour given in the figure below. Set X_o Y_o at the lower left-hand corner (point A) and Z_o at the top of the part.



N10 :G90 G40 G71 G94 G17

N20 T5 M06

N30 **(6.1)**1200 M03

N40 G00 X-1.0 Y-1.0Z-1.0

N50 G01 X0 Y0 **(6.2)**7.5 M8

N60 Y2.134

N70 **(6.3)** **(6.4)** Y3.866 P1.0

N80 **(6.5)** **(6.6)**

N90 G02 X0.5 **(6.7)** P0.5

N100 G01 X4.5

N110 **(6.8)** X6.0 Y4.5 **(6.9)**

N120 G01 Y0

N130 X0

N140 G00 X-1.0 Y-1.0Z10

N150 **(6.10)**

Answer

6.1 _____

6.2 _____

6.3 _____

6.4 _____

6.5 _____

6.6 _____

6.7 _____

6.8 _____

6.9 _____

6.10 _____

G Code Table Listing

Any program block can contain at most one code from each group. All codes except those in the Non-modal and Non-modal modifier group are *modal*, i.e., once a value is programmed it is effective until it is changed by programming another code from the same group. Each modal group has a default state, most of which are configurable. The codes marked "*" in the table are configurable reset states. Groups whose reset state is not configurable (such as CDC, which must default to "off" or G40, have the fixed default state shown with a double asterisk, "**"). The default state is made active at control power on, by a Data Reset, and at End of Program. Additionally, each modal group is also reset to its default state when an Alignment Block (: word) is encountered. Non-modal codes marked "Non-modal modifier" are permitted in blocks containing motion and modify the motion (G9) or the interpretation of the axis word values (G50, G98, and G98.1).

G Code		Group
G0*	Rapid Traverse (linear)	Interpolation
G1*	Linear Interpolation	Interpolation
G2	Circular/Helical CW	Interpolation
G2.01	Circular/Helical CW (absolute)	Interpolation
G2.02	Circular/Helical CW (incremental)	Interpolation
G3	Circular/Helical CCW	Interpolation
G3.01	Circular/Helical CCW (absolute)	Interpolation
G3.02	Circular/Helical CCW (incremental)	Interpolation
G4	Dwell	Non-modal
G7.1	Cylindrical Interpolation	Interpolation
G8	Suppress Interpolation	Interpolation
G9	Exact Stop	Non-modal Modifier
G12	Contouring Rotary Axis Unwind	Non-modal
G13.1**	Cylindrical Interpolation Off	Interpolation
G15.1*	Polar Coordinate Programming (bolt circle)	Polar Program Mode
G15.2*	Polar Coordinate Programming (part contour)	Polar Program Mode
G17*	XY Plane Select	Plane Select
G18*	YZ Plane Select	Plane Select
G19*	ZX Plane Select	Plane Select
G22, 22.1	Milling Cycle Rectangular Face	Interpolation
G23, 23.1	Milling Cycle Rectangular Pocket	Interpolation
G24, 24.1	Milling Cycle Rectangular Inside Frame	Interpolation
G25, 25.1	Milling Cycle Rectangular Outside Frame	Interpolation
G26	Milling Cycle Circular Face	Interpolation
G26.1	Milling Cycle Circular Pocket	Interpolation
G27	Milling Cycle Circular Inside Frame	Interpolation
G27.1	Milling Cycle Circular Outside Frame	Interpolation
G28	Auto Return to Reference Point	Non-modal
G29	Auto Return From Reference Point	Non-modal
G36	Move to Next Operation Location	Non-modal
G36.1	Test for End of Pattern	Non-modal
G37*	Cancel Pattern	Pattern Cycles
G38	Rectangular Pattern	Pattern Cycles
G39	Circle Pattern	Pattern Cycles

G Code		Group
G40**	Cutter Diameter Compensation OFF	CDC
G41	Cutter Diameter Compensation On LEFT	CDC
G42	Cutter Diameter Compensation On RIGHT	CDC
G43	PQR Cutter Diameter Compensation On	CDC
G45*	Acceleration/Deceleration ON	Acceleration/Deceleration
G45.01, 45.02, 45.03	User Specific Acceleration	Acceleration/Deceleration
G45.1	Acceleration/Deceleration ON (Die Roughing)	Acceleration/Deceleration
G45.2	Acceleration/Deceleration ON (Die Finishing)	Acceleration/Deceleration
G46*	Acceleration/Deceleration OFF	Acceleration/Deceleration
G50	Pallet Coordinates	Non-modal Modifier
G51	Probe Multiple Axes	Non Modal
G51.1	Vector Probe Surface and Set Offsets	Non Modal
G51.2	Rotary Axis measurement	Non Modal
G51.3	Angle Measurement in X or Y Plane	Non Modal
G51.4	Measure feature to feature XY Plane	Non Modal
G51.5	Measure feature to Feature Z Plane	Non Modal
G52	Local Coordinate System	Local Coordinates
G60*	Positioning Mode	Cornering
G61*	Contouring Mode	Cornering
G61.1	Automatic Corner Speed Override (Left)	Cornering
G61.2	Automatic Corner Speed Override (Right)	Cornering
G68	Tool Probe Cycle Set Tool Length	Non-modal
G69	Tool Probe Cycle Check Tool Length	Non-modal
G70*	Inch Programming	Inch/Metric
G71*	Metric Programming	Inch/Metric
G72	Set Stylus and Tip Dimension	Non-modal
G73	Set Probe Stylus Tip Dimension	Non-modal
G74	Set Probe Length	Non-modal
G75	Locate Internal Corner	Non-modal
G76	Locate External Corner	Non-modal
G77	Locate Surface	Non-modal
G77.1	Stock Allowance	Non-modal
G78	Locate and Measure Bore or Boss	Non-modal
G79	Measure Pocket or Web	Non-modal
G80	Reset Fixed Cycle	Interpolation Hole Making Cycle
G81	Drill Cycle	Interpolation Hole Making Cycle
G82	Counterbore/Spot Drill with Dwell Cycle	Interpolation Hole Making Cycle
G83	Deep Hole Drill (Peck Drill) Cycle	Interpolation Hole Making Cycle
G84	Tap Cycle (Conventional)	Interpolation Hole Making Cycle
G84.1	Rigid Tap Cycle	Interpolation Hole Making Cycle
G85	Bore/Ream Cycle	Interpolation Hole Making Cycle
G86	Bore Cycle	Interpolation Hole Making Cycle
G87	Back Bore Cycle	Interpolation Hole Making Cycle
G88	Web Drill/Bore Cycle	Interpolation Hole Making Cycle
G89	Bore/Ream with Dwell Cycle	Interpolation Hole Making Cycle
G90*	Absolute Dimension Input	Absolute/Incremental
G91*	Incremental Dimension Input	Absolute/Incremental
G92	Position Set	Non-modal
G92.1	Position Sets Setup Offset	Non-modal
G92.2	Position Sets Pallet Offset	Non-modal
G93	Inverse Time Feedrate (1/T)	Feedrate

G Code		Group
G94*	Feed Per Minute Feedrate Mode	Feedrate
G95*	Feed Per Revolution Feedrate Mode	Feedrate
G96	Constant Surface Speed	Spindle
G97*	Constant Spindle Speed (S = RPM)	Spindle
G97.1*	Constant Spindle Speed (S = Surface Speed)	Spindle
G98	Machine Coordinates (tool tip)	Non-modal Modifiers
G98.1	Machine Coordinates	Non-modal Modifiers
G99	Position Set Cancel	Non-modal
G150**	Scaling OFF	Scaling
G151	Scaling ON	Scaling

M Code Table Listing

In the Table below, each M code is shown as a member of a group. At most one M code from each group can appear in a block. Two or more M codes from the same group in the same block cause an alarm. For example, it is valid to code M3, M8, and M5 in one block. M3 and M8 start the spindle and coolant before axis motion begins, and M5 stops the spindle and coolant after axis motion completes. M codes for which no group is shown are independent, and can appear together in a block.

M Code Listing				
M CODE	GROUP	FUNCTION	START/ END OF BLOCK	MODAL
0	Prog Control	Program Stop	End	No
1	Prog Control	Optional Stop	End	No
2	Prog Control	End of Program (do not put tool away)	End	No
3	Spindle Start	Spindle ON CW	Start	Yes
4	Spindle Start	Spindle ON CCW	Start	Yes
5	Spindle Stop	Spindle and Coolant OFF	End	Yes
6	Tool Control	Tool Change	End	No
8		External Flood Coolant ON	Start	Yes
8.1 thru 8.8	Coolant Jets	Coolant Jets Position Control (option)	Start	Yes
9		Coolant OFF	End	Yes
10/10.x		Clamp Rotary Axis #1 -4	End	Yes
11/11.x		Unclamp Rotary Axis # 1 - 4)	Start	Yes
13	Spindle Start	Spindle ON CW, External Flood Coolant ON	Start	Yes
14	Spindle Start	Spindle ON CCW, External Flood Coolant ON	Start	Yes
19	Spindle Stop	Oriented Spindle Stop	End	Yes
26		Spindle Axis Full Retract	End	No
27		Through Spindle Coolant	Start	Yes
30	Prog Control	End of Program (put tool away)	End	No
34		Enable Data Acquisition	Start	Yes
35		Disable Data Acquisition	End	Yes

M Code Listing				
M CODE	GROUP	FUNCTION	START/ END OF BLOCK	MODAL
41	Spindle Mode	Select Spindle Constant Power Mode	Start	Yes
42	Spindle Mode	Select Spindle Constant Torque Mode	Start	Yes
48	Override	Feedrate & Spindle Speed Override Enable	Start	Yes
49	Override	Feedrate & Spindle Speed Override Disable	Start	Yes
58	Probe	Disarm Spindle Probe (Option)	Start	Yes
59	Probe	Arm Spindle Probe (Option)	Start	Yes
60 61	Swarf Wash	Swarf Wash ON Swarf Wash OFF	Start Start	Yes Yes
70 thru 79	User	User Definable M Codes (Option)	Start	
83		Part Complete		
91 92	Swarf Convey-or	Swarf Conveyor ON Swarf Conveyor OFF	Start Start	Yes Yes