Department of Mechanical Engineering
Indian Institute of Technology Kharagpur
End Semester Examination (Session 2008-2009)

Subject: Machine Tool and Machining (ME30604) 3rd Year ME, MF, IEM

Attempt all questions.
All parts of a particular question need to be answered serially

Full Marks: 100 Number of students: 150 Duration: 3 hours

1. *(a)* Draw a neat schematic diagram of a speed gear box of a centre lathe having 12 spindle speeds employing four shafts (the last shaft is the spindle itself) and combination of two sets of clutches and one sliding cluster having three gears. [8]

1. *(b)* The pitch of the lead screw of a centre lathe is 6 mm. A metric thread of 2 mm pitch is required to be machined. The transmission ratios of the change gear quadrant and Meander drive are both 0.5. The output of the meander is directly connected to the lead screw. If the numbers of teeth on the gears in Tumbler (connected to the Norton cone) are both 36, determine the number of teeth on the matching gear on the Norton Cone. [6]

1. *(c)* The observed tool lives while machining medium carbon steel with uncoated carbide insert are 24 and 12 minutes respectively for cutting velocities of 60 m/min and 90 m/min. Determine the cutting velocity, when a tool life of 15 min. is expected. [6]

2. *(a)* The transmission ratios of a Meander drive are 1, 0.5, 0.25 and 0.125. Draw the schematic of the same with suitable gears. [8]

2. *(b)* Typically what type of rake angle is provided to tungsten carbide turning tool inserts and why? [6]

2. *(c)* A low carbon steel bar has been turned with a tool without nose radius. Find out the relationship between theoretical peak to valley surface roughness (h_m) and theoretical centre line average (R_a). [6]

3. *(a)* The amount of heat taken away by the chip from the primary shear zone is 70% while machining low carbon steel. The thermal conductivity, specific heat and density of low carbon steel are 50 W/m-K, 500 J/kg-K and 7800 kg/m^3. The feed, depth of cut and cutting velocity are 0.4 mm/rev, 4 mm and 100 m/min. The chip reduction coefficient is 2 and the principal cutting edge angle is 90^0. The orthogonal rake is 0^0 and dynamic yield shear strength is 500 MPa. Determine the rise in temperature in the chip due to primary shear zone. [12]

3. *(b)* In orthogonal turning of an engineering alloy, the following information are available: [8]
$S = 0.2$ *mm/rev*, $t = 3$ *mm*, $V_C = 90$ *m/min*, $\phi = 60^0$, $a_2 = 0.37$ *mm*, $\gamma_o = 0^0$.
The alloy exhibit 30% elongation during tensile testing. $P_Y = 200$ *N*. Determine dynamic yield shear strength.

4. *(a)* A low carbon steel bar is being turned by a single point turning tool having a nose radius of $r = 0.8$ *mm*, when the depth of cut $t = 0.4$. The inclination angle is zero. Neglecting the effect of auxiliary cutting edge, determine the angle and sense (towards work material or tool) of chip deviation. $\phi = 75^0$ and $\phi_1 = 15^0$. [8]

4. *(b)* A steel bar of diameter 100 mm and length 400 mm is being straight turned with uncoated carbide insert at a cutting velocity of 90 m/min and feed of 0.2 mm/rev. The tool life is 20 minutes. The idle and tool setting time is 1 min. The tool change time is 1 min. The approach and over travel are both 5 mm. Determine the machining time (**not** the cycle time per piece). [6]

4. *(c)* Under orthogonal turning, it has been observed that P_{XY} = F (Friction Force at the chip-tool interface) and P_Z = N (Normal Force at the chip-tool interface). The chip thickness and thickness of uncut layer (a_1) are 0.4 mm and 0.24 mm respectively. Calculate shear angle. [6]

5. *(a)* Find an expression for the rake angle of single point turning tool as measured on the auxiliary cutting plane as a function of orthogonal rake angle, inclination angle and other relevant angles. [6]

5. *(b)* Show the variation in chip reduction coefficient with feed while turning low carbon steel with uncoated carbide insert **and explain the nature of variation**. The feed range is from 0.04 mm/rev to 0.4 mm/rev, depth of cut is 4 mm and cutting velocity is 90 m/min. [4]

5. *(c)* For a single point turning tool, the following information is available: γ_X = negative γ_Y=positive, $\phi < 90^0$, $\phi_1 < 45^0$. Draw the master line for the rake surface. Derive the interrelation between inclination angle and γ_X, γ_Y and ϕ. [6]

5. *(d)* When would you use cutting fluid (i) for cooling and (ii) for lubrication while turning low carbon steel? [4]