



Theory of Metal Cutting
Answer the Following Questions

Question (1) : (25 Mark)

- a) Explain with neat sketch the basic mechanics of chip formation.
- b) Define the different types of chip formation and the reasons leading to each one.
- c) An AISI-4340 steel workpiece with 150mm diameter is to be cut with neutral rake angle carbide tool. The cutting conditions are set as follows: cutting speed = 650 m/min, feed rate = 6 mm/min, depth of cut = 0.5 mm, deformed chip thickness = 1mm, tangential force = 1500N, radial force = 800N. Assume that the turning process is orthogonal cutting process. Determine graphically: the resultant cutting force, shear force, normal force acting on the shear plane, friction and normal forces, friction angle, and coefficient of friction.

Question (2) : (35 Mark)

- a) State the advantages, limitations, and applications of the following tool materials:
 1. Cemented carbide tools.
 2. Diamond Tools.
- b) Describe the heat flow in metal cutting.
- c) Illustrate with neat sketches two different methods for measuring temperature in metal cutting.
- d) A single point tool has a rake angle of 12° used to cut a section of mild steel rod. The workpiece diameter = 60mm, and the spindle speed = 640r.p.m. Calculate the maximum temperature along the tool face where the main cutting force = 750 N, frictional force = 645N, undeformed chip thickness = 0.2mm, width of cut = 2.5 mm, chip thickness = 0.8mm, length of contact between the chip and tool = 0.9mm, the Specific Heat Capacity (c) = 475 J/kg. $^\circ$ c, density = 7840kg/m 3 , and the thermal conductivity (K) = 44.5W/m. $^\circ$ c. The proportion of the shear zone heat conducted into the workpiece Γ has the following values:

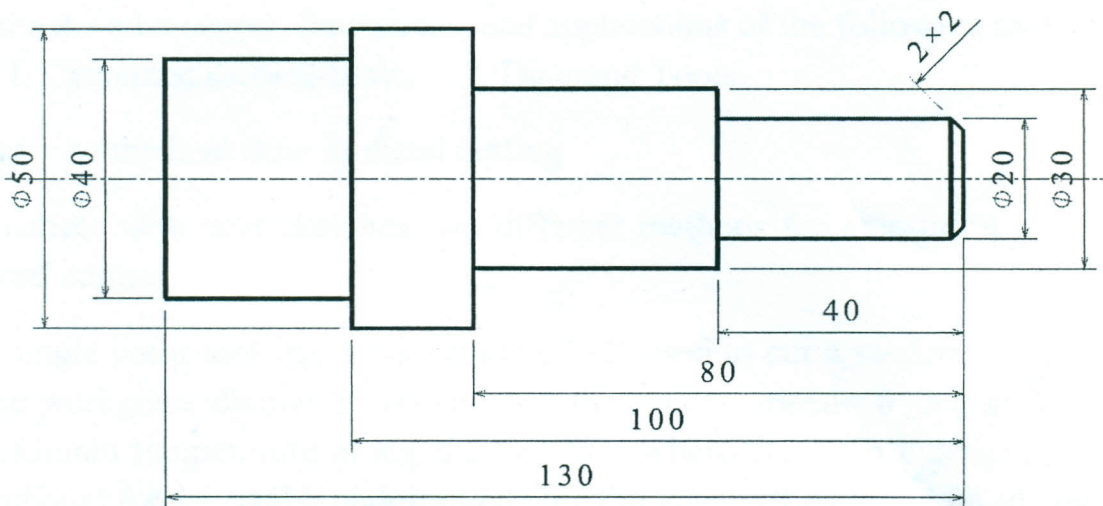
Γ	0.06	0.08	0.12	0.2	0.34	0.45
R tan ϕ	30	20	10	5	2	3

Question (3): (25 Mark)

- a) Define the various kinds of tool wear.
- b) Define the factors affecting tool life and their influence.
- c) State the advantages of cutting fluid applications.
- d) When choosing a coolant, many factors need to be considered. Define these factors and what are the characteristics of a good cutting fluid?

Question (4): (25 Mark)

- a) Define in detail the meaning of machinability and what are the factors used for judging the machinability?
- b) Estimate the cutting time for machining on the centre lathe for the shaft shown below from 60 mm dia x 140 mm cold drawn bar. The cutting speeds and feeds based on the use of carbide tools are $V = 100$ m/min and $f = 0.1$ mm/rev. The maximum allowable depth of cut = 2mm. Available spindle speeds (r.p.m) are: 35, 56, 71, 112, 180, 224, 280, 355, 450, 560, 710, and 900.



Good Luck for All of You & Happy New Year
Prof.Dr. Tawfik El-Midany