Kafrelsheikh University
Faculty of Engineering
Department of Mech. Eng.
3ed year Mechanical Design & Production
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Time allowed: 3 H.
Full Mark: 75
Final year exam
MDP3216

Theory and technology of metal cutting

Question 1 (10 Marks)

For the case of $\lambda = 0$ and a setting angle of 90° if the normal rake angle is 10°, the normal relief angle is 7°, cutting speed is 200 mm/min, the tool feed rate is 20 mm/min, and the tool nose is set at 2 mm above the center, calculate the actual rake and clearance angles if the workpiece diameter is 200 mm.

Question 2 (١٠ Marks)

In an orthogonal cutting test of a collar, the following data are known:

F_v	2000 N
F_t	1000 N
Rake angle	-15°
Velocity of tool advance	40 m/min
Chip thickness	3 mm
Thickness of unreformed chip	1.2 mm

Calculate
a. Cutting ratio
b. Coefficient of friction
c. Mean shear stress on shear plane
d. Velocity of chip flow on the tool face
e. Main (cutting) power
f. Material removal rate

Queston 3 (10 Marks)

The durability of a cutting tool is 40 min at a cutting speed of 120 m/min and 100 min at a cutting speed of 60 m/min; calculate
a. The tool life at $V = 70$ m/min
b. The tool life at $V = 180$ m/min

Question 4 (12 Marks)

Two thousand bars 80mm diameter and 300mm long must be turned down to 65mm diameter for 150mm of their length. The surface finish and accuracy requirements are such that a heavy roughing cut (removing most of the material) followed by a light finishing cut are needed. The roughing cut is to be taken at maximum power. The light finishing cut is to be taken at a feed of 0.13mm/rev and a cutting speed of 1.5m/s, and at maximum power.
If the lathe has 2kW motor and an efficiency of 50 percent, calculate the total production time in kiloseconds (ks) for the batch of work. Assume that the specific cutting energy for the work material is $2.73 GN/m^2$, the time taken to return the tool to the beginning of the cut is 15s, and the time taken to load and unload a workpiece is 120s.

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Question 5 **(11 Marks)**

In a drilling operation using a twist drill, the rotational frequency of a drill is 5 s-l, the feed 0.25 mm per revolution, the major cutting-edge angle 60deg, and the drill diameter 12 mm. Assuming that the specific cutting energy for the work material is 2 GN/m2, calculate

a. The maximum metal removal rate
b. The undeformed chip thicknesses (h)
c. The drill torque, in Newton-meters (N-m)

Question 6 **(11 Marks)**

For a shaping process under the following conditions

Cutting speed	= 15 m/min
Feed rate	= 0.6 mm/stroke
Depth of cut	= 3.2 mm
Workpiece	= CI block 200 mm × 300 mm
Specific cutting energy	= 2500 N/mm^2
Shaper: no. of strokes/min	= 12, 19.5, 30.7, 49, 78.6, and 125.8

a. Select a suitable number of strokes/min if the quick return ratio = $V_r/V = 2$.
b. Calculate the machining time.
c. Calculate the machining power.
d. Calculate the motor power if the machine efficiency is 85%.

Question 7 **(11 Marks)**

During a vertical milling operation for cast iron block of 600 mm length, the consumed power is 1.2 kW when using a cutter, having 100 mm diameter and 6 teeth, depth of cut 6 mm, workpiece feed rate 200 mm/min, cutting speed 20 m/min, and a cutting width of 40 mm. Take Δ = 5 mm. (6 Marks)

Calculate

a. The cutter rotational speed
b. The specific cutting energy
c. The machining time for one travel

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