Machine Tool Numerical

1. Find the angle at which the compound rest should be set for carrying out a taper turning operation on a job 140 mm long, having a diameter of 100 mm. The smallest diameter on the tapered end should be 70 mm and the required length of the tapered portion is 100 mm.

Solution

D = 100 mm; d = 70 mm; l = 100 mm

$$\tan\alpha = \frac{(D-d)}{2l}$$

$$\tan\alpha = \frac{(100-70)}{2\times 100}$$

$\therefore \alpha$ = 8.53° (Ans)

2. A cast iron shaft has a length of 80 mm with a tapered portion of length 50 mm. Major diameter of taper is 90 mm while minor diameter is 80 mm. Determine;

a. Taper in mm/meter

b. angle to which compound rest should be swivelled

c. Tail stock set over

Solution

D = 90 mm; d = 80 mm; L = 80 mm; l = 50 mm

$$\text{Taper} = \frac{(D-d)}{l}$$

$$\text{Taper} = \frac{(90-80)}{50} = \frac{10}{50}$$

Which means that for a length of 50 mm, taper is 10 mm

Swivelling the compound rest

$$\tan\alpha = \frac{(D-d)}{2l}$$

$$\tan\alpha = \frac{(90-80)}{2\times 50}$$

$\therefore \alpha$ = 5.71° (Ans)

Tail Stock Set-over

$$S = \frac{L\,(D-d)}{2l}$$

$$S = \frac{80\ \times (90-80)}{2 \times 50}$$

S = 8 mm (Ans)

3. A hollow workpiece of 40 mm in diameter and 150 mm in length is to be turned all over in 4 passes. If approach length is 20 mm, over travel of 10 mm, feed 0.3 mm/rev and cutting speed 30 m/min, estimate the machining time.

Solution

Cutting speed

$$V = \frac{\pi DN}{1000}$$

$$30 = \frac{\pi\ \times 40\ \times N}{1000}$$

$\therefore$ N = 238.73 rpm

Over travel of the tool beyond the length of the job, Lo = 20 + 10 = 30 mm

Time for single pass

$$t = \frac{L + L_O}{fN}$$

$$t = \frac{150 + 30}{0.3 \times\ 238.73}$$

T = 2.51 min

$\therefore$ Time required for 3 passes = 2.51 x 3 = **7.53 min (Ans)**

4. Estimate the time required to machine a job 160 mm long, 50 mm in diameter to 155 mm length and 40 mm in diameter when job rotates at 400 rpm, feed 0.2 mm/rev and maximum depth of cut 2 mm. Take tool approach and overall travel distance as 10 mm for the turning operation while for the facing operation the tool over travel can be taken as 2 mm.

Solution

Turning operation

Since diameter must be turned down from diameter 50 mm to 40 mm with maximum depth of cut being 2 mm, minimum number of passes required would be,

Reduction in diameter = 10 mm

∴reduction radially = 5 mm

With depth of cut not more than 2 mm

minimum number of passes required = 5/2 = 2.5 i.e. **3**

Time required of single pass

$$t = \frac{L + L_O}{fN}$$

$$t = \frac{160 + 10}{0.2 \times 400} = 2.125\ min$$

∴for 3 passes total time required for machining = 2.125 x 3 = **6.4 min**

Facing Operation

Diameter = 40 mm

Minimum number of passes required = 5/2 = 2.5 i.e. 3 passes

Since during facing length of tool travel is half that of the diameter,

L = 20 mm

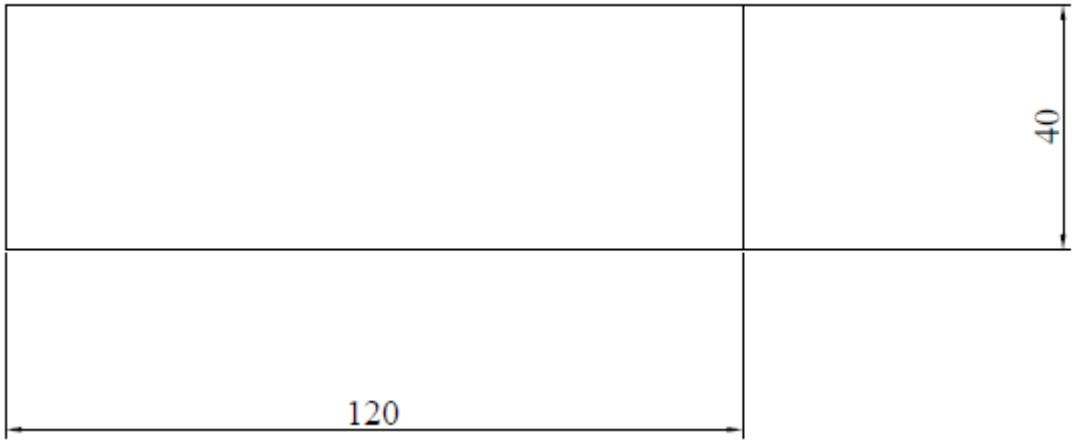
$$t = \frac{L + L_O}{fN}$$

$$t = \frac{20 + 2}{0.2 \times 400} = 0.275\ min$$

∴for 3 passes total time required for machining = 0.275 x 3 = **0.83 min**

∴Total machining time is 6.4 + 0.83 = 7.23 min (Ans)

5. Estimate the actual machining time required for the component shown in the Figure below. The available spindle speeds are 70, 110, 176, 280, 440, 700, 1100, 1760 and 2800 rpm. Use a roughing speed of 30 m/min and finish speed of 60 m/min. The feed for roughing is 0.24 mm/rev while that for finishing is 0.10 mm/rev. The maximum depth of cut for roughing is 2 mm. Finish allowance may be taken as 0.50 mm. Blank to be used for machining is 50 mm in diameter. Take over travel of tool as 5 mm on either side of the job.



All Dimensions are in mm.

Solution

Stock to be removed = (50 – 40) / 2 = 5 mm

Finish allowance = 0.50 mm

Roughing operation

$$P_r = \frac{A - A_f}{d_r}$$

$$P_r = \frac{5 - 0.50}{2} = 2.5$$

∴ 3 minimum roughing passes are required.

Cutting speed, V = 30 m/min

Spindle speed

$$V = \frac{\pi DN}{1000}$$

$$30 = \frac{\pi \times 50 \times N}{1000}$$

∴N = 190.98 rpm.

The nearest rpm available from the above list is 176 rpm.

∴Machining time for one pass

$$t = \frac{L + L_O}{fN}$$

$$t = \frac{120 + 10}{0.24 \times 176} = 3.078\ min$$

For 3 passes, total time required = 3 x 3.078 = 9.23 min.

Finishing operation

Cutting speed, V = 60 m/min

Spindle speed

$$V = \frac{\pi DN}{1000}$$

$$60 = \frac{\pi \times 41 \times N}{1000}$$

∴N = 465.82 rpm

The nearest rpm available from the above list is 440 rpm.

Also, since finishing allowance is 0.50 mm, one finishing pass is required.

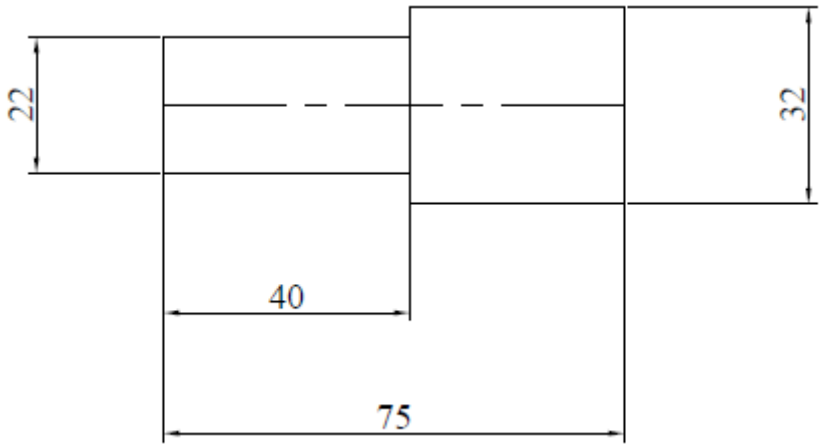
∴Machining time for one pass

$$t = \frac{L + L_O}{fN}$$

$$t = \frac{120 + 10}{0.10 \times 440} = 2.95\ min$$

∴Total machining time required is 9.23 + 2.95 = 12.18 min.

6. In the Figure below, component to be machined from a stock of CRS C40 steel, 40 mm in diameter and 75 mm long is shown. Calculate the machining times required for completing the part with a) HSS tool, and b) Carbide tool. Maximum depth of cut = 2 mm. Over travel = 5 mm on either side.



All Dimensions are in mm

Solution

Using HSS tool

From Table

V = 30 m/min and f = 0.30 mm/rev.

Stock to be removed = (40 – 32) / 2 = 4 mm

Depth of cut = 2 mm. ∴ 2 passes are required

Spindle speed

$$V = \frac{\pi DN}{1000}$$

$$30 = \frac{\pi \times 40 \times N}{1000}$$

∴N = 238.73 rpm

∴Machining time for one pass

$$t = \frac{L + L_O}{fN}$$

$$t = \frac{75 + 10}{0.30 \times 238.73} = 1.19\ min$$

∴Time required for 2 passes = 2.38 min.

Stock to be removed = (32 – 22) / 2 = 5 mm

Depth of cut = 2 mm. ∴ 3 passes are required

Spindle speed

$$V = \frac{\pi DN}{1000}$$

$$30 = \frac{\pi \times 32 \times N}{1000}$$

∴N = 298.41 rpm

∴Machining time for one pass

$$t = \frac{L + L_O}{fN}$$

$$t = \frac{40 + 5}{0.30 \times 298.41} = 0.50\ min$$

∴Time required for 3 passes = 1.50 min.

∴Total time required for machining using HSS tool = 2.38 + 1.50 = 3.88 min **(Ans.)**

Using Carbide tool

From Table

V = 145 m/min and f = 0.38 mm/rev.

Stock to be removed = (40 – 32) / 2 = 4 mm

Depth of cut = 2 mm. ∴ 2 passes are required

Spindle speed

$$V = \frac{\pi DN}{1000}$$

$$145 = \frac{\pi \times 40 \times N}{1000}$$

∴N = 1153.87 rpm

∴Machining time for one pass

$$t = \frac{L + L_O}{fN}$$

$$t = \frac{75 + 10}{0.38 \times 1153.87} = 0.19\ min$$

∴Time required for 2 passes = 0.38 min.

Stock to be removed = (32 – 22) / 2 = 5 mm

Depth of cut = 2 mm. ∴ 3 passes are required

Spindle speed

$$V = \frac{\pi DN}{1000}$$

$$145 = \frac{\pi \times 32 \times N}{1000}$$

∴N = 1442.34 rpm

∴Machining time for one pass

$$t = \frac{L + L_O}{fN}$$

$$t = \frac{40 + 5}{0.38 \times 1442.34} = 0.08\ min$$

∴Time required for 3 passes = 0.246 min.

∴Total time required for machining using Carbide tool = 0.38 + 0.26 = 0.64 min. **(Ans.)**