

ESE

GATE

State Engg. Exams

MADE EASY
WORKBOOK 2027



**Detailed Explanations of
Try Yourself *Questions***

**Mechanical Engineering
Production Engineering**



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Basic Machining Calculations



Detailed Explanation of Try Yourself Questions

T1 : Solution

Given: $D_{\min} = 100$ mm, $D_{\max} = 200$ mm, $V_{\min} = 40$ m/min, $V_{\max} = 120$ m/min

Number of gear speed, $n = 6$

Now because speed are in geometric progression:

$$\text{So, } r = \sqrt[n-1]{\frac{N_{\max}}{N_{\min}}} = \sqrt[n-1]{\left(\frac{V_{\max}}{D_{\min}}\right) \times \left(\frac{D_{\max}}{V_{\min}}\right)}$$

$$r = \left(\frac{120 \times 200}{100 \times 40}\right)^{\frac{1}{6-1}} = (6)^{0.2} = 1.431$$

Now, let minimum rotational speed is N_1 .

$$\text{Now, } V = \frac{\pi DN}{1000} \quad [\text{where velocity is in m/min and diameter is in mm}]$$

$$V_{\min} = \frac{\pi D_{\max} \times N_{\min}}{1000}$$

$$N_1 = N_{\min} = \frac{40 \times 1000}{\pi \times 200} = \frac{200}{\pi} = 63.66 \text{ rpm}$$

$$N_2 = rN_1 = (1.431) \times (63.66) = 91.10 \text{ rpm}$$

$$N_3 = r^2N_1 = (1.431)^2 \times (63.66) = 130.36 \text{ rpm}$$

$$N_4 = r^3N_1 = (1.431)^3 \times (63.66) = 186.55 \text{ rpm}$$

$$N_5 = r^4N_1 = (1.431)^4 \times (63.66) = 266.95 \text{ rpm}$$

$$N_6 = r^5N_1 = (1.431)^5 \times (63.66) = 382.00 \text{ rpm}$$

$$\text{or } N_{\max} = \frac{V_{\max} \times 1000}{\pi D_{\min}} = \frac{120 \times 1000}{\pi \times 100} = 381.97 \approx 382 \text{ rpm}$$



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Drilling Boring and Reaming



Detailed Explanation of Try Yourself Questions

T1 : Solution

$$\text{Speed } (N) = \frac{1000 V}{\pi D} = \frac{1000 \times 20}{\pi \times 20}$$

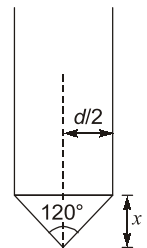
$$= 318.3 \text{ rpm}$$

$$x = \frac{20}{2 \times \tan 60^\circ} = 5.7735 \text{ mm}$$

$$\text{Length to be machined, } L = l + \text{approach} + \text{overrun} + x$$

$$= 30 + 2 + 3 + x = 35 + 5.7735 = 40.7735 \text{ mm}$$

$$\text{Time taken} = \frac{L}{f \cdot N} = \frac{40.7735}{0.1 \times 318.3} = 1.28 \text{ min}$$



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Milling



Detailed Explanation of Try Yourself Questions

T1 : Solution

Width of slot, $b = 20$ mm
Length of slot, $l = 100$ mm

$$N = \frac{1000 \times V}{\pi D} = \frac{1000 \times 60}{\pi \times 20} \approx 955 \text{ rpm}$$

Cutting length = length of slot + approach

$$= 100 + \frac{D}{2} = 100 + \frac{20}{2} = 110 \text{ mm}$$

$$\text{Time/cut} = \frac{L}{f_z N} = \frac{110}{0.01 \times 8 \times 955} = 1.44 \text{ min}$$

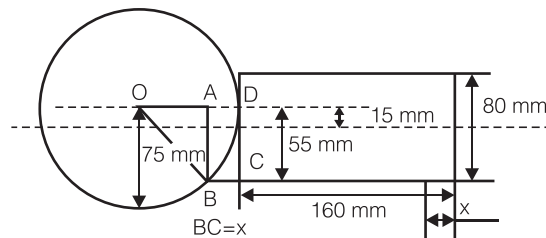
T2 : Solution

Given: $D = 150$ mm; Width, $b = 80$ mm ; Offset, $O_f = 15$ mm ; Number of teeth, $z = 10$
 $l = 160$ mm, Feed, $f = 0.25$ mm

$$V_c = 20 \text{ m/min}$$

$$N = \frac{1000 V}{\pi D} = \frac{1000 \times 20}{\pi \times 150} = 42.44 \text{ rpm}$$

$$\text{Length of approach, } l_0 = x = 75 - \sqrt{75^2 - 55^2} = 24.0098 \approx 24 \text{ mm}$$



$$\text{Length of machining, } L = l + l_0 = 160 + 24 = 184 \text{ mm}$$

$$\text{Time required for rough machining} = \frac{L}{f_z N} = \frac{184}{0.25 \times 10 \times 42.44} = 1.734 \text{ minute/cut}$$



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Non-conventional Machining Operation



Detailed Explanation of Try Yourself Questions

T1 : Solution

$$\frac{1}{e} = \frac{\sum \% \times \text{Valency}}{\text{Atomic weight}} = \frac{0.18 \times 2}{58.93} + \frac{0.62 \times 2}{58.71} + \frac{0.2 \times 6}{51.99} = 0.050311$$

$$e = 19.876$$

$$\text{MRR} = SI$$

⇒

$$\frac{eI}{F_p} = \frac{19.876 \times 500}{96500 \times 8.28}$$

$$\text{MRR} = 0.0124 \text{ cm}^3/\text{s}$$

T2 : Solution

Charging resistance, $R = 40 \Omega$; Charging capacitance, $C = 20 \mu\text{F}$

Supply voltage, $V_s = 220 \text{ V}$; Charging voltage, $V_c = 110 \text{ V}$

$$\text{Cycle time} = RC \ln \left[\frac{V_s}{V_s - V_c} \right] \text{ second}$$

$$= 40 \times 20 \times 10^{-6} \ln \left[\frac{220}{110} \right] = 0.55 \text{ ms}$$

Total energy consumed per cycle (or)

$$\text{spark energy} = 0.5 CV_c^2 = 0.5 \times 20 \times 10^{-6} \times (110)^2 = 0.121 \text{ J/Cycle}$$

$$\text{Average power input} = \frac{\text{Total energy consumed per cycle}}{\text{cycle time}}$$

$$= \frac{0.121}{0.55 \times 10^{-3}} = 0.22 \text{ kW}$$





**Detailed Explanation
of
Try Yourself Questions**

T1 : Solution

$$\begin{aligned}
 \text{Metal deposition rate} &= d \times t \times v \\
 &= 0.5 \times 25 \times v \text{ mm}^3/\text{s} \\
 &= 125v \times 10^{-10} \text{ m}^3/\text{s} \\
 \dot{m} &= 125v \times 10^{-10} \text{ m}^3/\text{s} \times 8000 \text{ kg/m}^3 \\
 &= v \times 10^{-4} \text{ kg/s} \\
 V \times I \times \eta &= \dot{m}L + mc_p \Delta T \\
 300 \times 10 \times 0.6 &= v \times 10^{-4} \{1400 \times 10^3 + 0.5 \times 10^3 \times (1500 - 20)\} \\
 1800 &= v \{214\} \\
 v &= \frac{1800}{214} = 8.41 \text{ mm/s}
 \end{aligned}$$

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Detailed Explanation of Try Yourself Questions

T1 : Solution

For optimum cylindrical side riser, $h = d$
 Volume of casting, $V_c = 25 \times 12.5 \times 5$
 $= 1562.5 \text{ cm}^3$

Shrinkage of steel during solidification = 3%

Minimum volume of the riser necessary is,

$$V_r = 0.03 V_c \times 3$$

$$V_r = 46.875 \text{ cm}^3 \times 3$$

$$= 140.625 \text{ cm}^3$$

$$V_r = \frac{\pi}{4} d^2 h = \frac{\pi}{4} d^3$$

or $d = \left(\frac{4V_r}{\pi} \right)^{1/3} = \left(\frac{4 \times 140.625}{\pi} \right)^{1/3} = 5.636 \text{ cm}$

Dimension of optimum riser, $h = d = 5.636 \text{ cm}$

T2 : Solution

Given: Aluminium cube side, $a = 10 \text{ cm}$, For cylindrical riser, $h = d$, Volume shrinkage = 6%

(i) Shrinkage volume of cube on solidification = 6% of cube volume

$$= \frac{6 \times a^3}{100} = \frac{6 \times 10^3}{100} = 60 \text{ cm}^3$$

(ii) Riser volume, $V_r = 3 \times (\text{shrinkage volume})$

$$V_r = 3 \times (0.06 \times 10^3)$$

$$\frac{\pi}{4} d^2 h = 180 \text{ cm}^3$$

$$\frac{\pi}{4}d^3 = 180 \quad \{\because d = h\}$$

$$d = \left[\frac{180 \times 4}{\pi} \right]^{\frac{1}{3}} = 6.12 \text{ cm}$$

$$\left(\frac{V}{A} \right)_c = \frac{a^3}{6a^2} = \frac{a}{6} = \frac{10}{6} = 1.667$$

$$\left(\frac{V}{A} \right)_r = \frac{\frac{\pi}{4}d^2h}{\pi dh + 2 \times \frac{\pi}{4}d^2} = \frac{\frac{\pi}{4}d^3}{\pi d^2 + \frac{\pi}{2}d^2} = \frac{\frac{d}{4}}{\left(\frac{3}{2} \right)} = \frac{d}{6} = \frac{6.12}{6} = 1.02$$

We know that,

$$\left(\frac{V}{A} \right)_r \geq \left(\frac{V}{A} \right)_c$$

Which is not true for the given riser design.

So redesigning the riser.

$$\left(\frac{V}{A} \right)_r \geq \left(\frac{V}{A} \right)_c$$

$$\frac{d}{6} \geq 1.667$$

$$d \geq 10 \text{ cm}$$

So, minimum diameter of riser, $d = 10 \text{ cm}$

Minimum height of riser, $h = d = 10 \text{ cm}$

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