ESE GATE PSUs

State Engg. Exams

MADE EASY WORKBOOK 2024

Detailed Explanations of Try Yourself *Questions*

Mechanical Engineering

Production Engineering

MADE EASY PUBLICATIONS

4 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:

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.

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

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

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

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

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

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

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

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

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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5 Shapping and Planning

Detailed Explanation of Try Yourself Questions

T1 : Solution

$$\text{Time taken in one stroke} = \frac{1}{60}\text{min}$$

$$\text{Total number of stroke} = \frac{\text{Width}}{\text{Lateral feed}}$$

$$\Rightarrow \quad \text{Total time/cut} = \frac{\text{Width}}{\text{Feed}} \times \frac{1}{60}$$

$$= \frac{36}{0.6} \times \frac{1}{60} = 1\,\text{min.}$$

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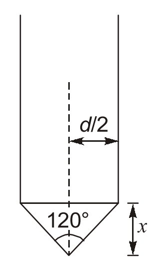
6 Drilling Boring and Reaming

Detailed Explanation of Try Yourself Questions

T1 : Solution



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

$$= 318.3 \text{ rpm}$$

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

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

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

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

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7 Milling

Detailed Explanation of Try Yourself Questions

T1 : Solution

Width of slot, b = 20 mm

Length of slot, l = 100 mm

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

$$\text{Cutting length} = \text{length of slot} + \text{approach}$$

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

$$\text{Time/cut} = \frac{L}{f_1 z N} = \frac{110}{0.01 \times 8 \times 955} = 1.44 \text{ min}$$

T2 : Solution

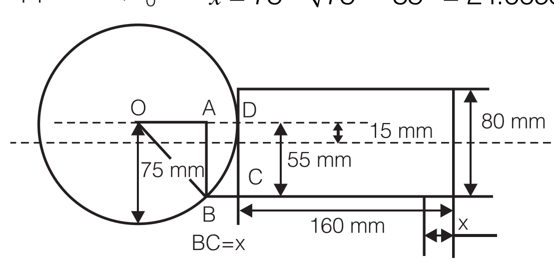
Given: D = 150 mm; Width, b = 80 mm ; Offset, O_f = 15 mm ; Number of teeth, z = 10

l = 160 mm, Feed, f = 0.25 mm

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

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

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



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

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

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10 Non-conventional Machining Operation

Detailed Explanation of Try Yourself Questions

T1 : Solution

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

$$e = 19.876$$

$$\text{MRR} = SI$$

$$\Rightarrow \quad \frac{eI}{F\rho} = \frac{19.876 \times 500}{96500 \times 8.28}$$

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

T2 : Solution

Charging resistance, R = 40 Ω ; Charging capacitance, C = 20 μF

Supply voltage, V_s = 220 V ; Charging voltage, V_c = 110 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)

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

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

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

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20 Welding

Detailed Explanation of Try Yourself Questions

T1 : Solution

Given: Volume of nuget, V_n = 80 mm^3, Current, I = 10000 A,
Energy required for melting of material = 10 J/mm^3, Heat lost to surrounding = 500 J,
Contact resistance, R = 200 $\mu\Omega$.
Energy required to melt nugget = 80 × 10 = 800 J
Total energy supplied = 500 + 800 = 1300 J

(i) Total energy supplied, $I^2Rt = 1300$

$$t = \frac{1300}{(10000)^2 \times 200 \times 10^{-6}}$$

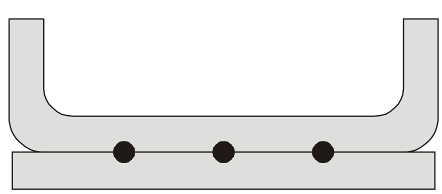
Time rquired for welding, t = 0.065 second

(ii) Thermal efficiency of the welding process,

$$\eta = \frac{800}{1300} = 0.61538$$

$$\eta = 61.538\%$$

T2 : Solution



Projection welding:
3 spots
I = 35000 A, t = 0.01 s, R = 360 $\mu\Omega$, d = 4 mm, h = 2.5 mm, H = 10 J/mm^3
Heat distributed to the surrounding

$$H_d = H_s - H_m$$

$$= \left(I^2Rt\right)3 - \left(\frac{\pi}{4}d^2 \cdot h\right)3$$

$$= ((35000)^2 \times 360 \times 10^{-6} \times 0.01)3 - \left(\frac{\pi}{4}(4)^2 \times 2.5 \times 10\right)3$$

$$= 13230 - 942.477$$

$$= 12287.522 \text{ J} = 12.287 \text{ kJ}$$

T3 : Solution

$$\text{Metal deposition rate} = d \times t \times v$$

$$= 0.5 \times 25 \times v \text{ mm}^3/\text{s}$$

$$= 125v \times 10^{-10} \text{ m}^3/\text{s}$$

$$\dot{m} = 125v \times 10^{-10} \text{ m}^3/\text{s} \times 8000 \text{ kg/m}^3$$

$$= v \times 10^{-4} \text{ kg/s}$$

$$V \times I \times \eta = \dot{m}L + mc_p\Delta T$$

$$300 \times 10 \times 0.6 = v \times 10^{-4}\left\{1400 \times 10^3 + 0.5 \times 10^3 \times (1500 - 20)\right\}$$

$$1800 = v\{214\}$$

$$v = \frac{1800}{214} = 8.41 \text{ mm/s}$$

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21 Conventional Casting Process

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, $h = d = 5.636$ cm

T2 : Solution

Given: Aluminium cube side, a = 10 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, $V_r = 3 \times$ (shrinkage volume)

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

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

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

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

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

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

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 cm

Minimum height of riser, $h = d$ = 10 cm

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