予習問題
解答省略

演習問題解答

A 1

(a)

(1)----------

$A = 1.5 \times 10^5 (\mathrm{mm}^2)$,

$G_x = \int_0^{600} 250 y dy = 4.5 \times 10^7 (\mathrm{mm}^3), G_y = \int_0^{250} 600 x dx = 1.875 \times 10^7 (\mathrm{mm}^3)$

$x_0 = \frac{G_y}{A} = \frac{1.875 \times 10^7}{1.5 \times 10^5} = 125 (\mathrm{mm}), y_0 = \frac{G_x}{A} = \frac{4.5 \times 10^7}{1.5 \times 10^5} = 300 (\mathrm{mm})$

(2)

$I_X = \frac{250 \cdot 600^3}{12} = 4.5 \times 10^9 (\mathrm{mm}^4), I_Y = \frac{600 \cdot 250^3}{12} = 7.81 \times 10^8 (\mathrm{mm}^4)$

(3)

$Z_X = \frac{I_X}{300} = \frac{4.5 \times 10^9}{300} = 1.50 \times 10^7 (\mathrm{mm}^3), Z_Y = \frac{I_Y}{125} = \frac{7.81 \times 10^8}{125} = 6.25 \times 10^6 (\mathrm{mm}^3)$

(4)

$i_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{4.5 \times 10^9}{1.5 \times 10^5}} = 17.3 (\mathrm{mm}), i_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{7.81 \times 10^8}{1.5 \times 10^5}} = 72.2 (\mathrm{mm})$

173

(b)----------

(1)

$A = 4.0 \times 10^4 (\mathrm{mm}^2)$,

$G_x = \int_0^{50} 400 y dy + \int_{550}^{600} 400 y dy = 1.20 \times 10^7 (\mathrm{mm}^3), G_y = \int_0^{400} 100 x dx = 8.00 \times 10^6 (\mathrm{mm}^3)$

$x_0 = \frac{G_y}{A} = \frac{8.00 \times 10^7}{4.0 \times 10^4} = 200 (\mathrm{mm}), y_0 = \frac{G_x}{A} = \frac{1.2 \times 10^7}{4.0 \times 10^4} = 300 (\mathrm{mm})$

(2)

$I_X = \frac{400 \cdot 600^3}{12} - \frac{400 \cdot 500^3}{12} = 3.03 \times 10^9 (\mathrm{mm}^4), I_Y = \frac{600 \cdot 400^3}{12} - \frac{500 \cdot 400^3}{12} = 5.33 \times 10^8 (\mathrm{mm}^4)$

(3)

$Z_X = \frac{I_X}{300} = \frac{3.03 \times 10^9}{300} = 1.01 \times 10^7 (\mathrm{mm}^3), Z_Y = \frac{I_Y}{200} = \frac{5.33 \times 10^8}{200} = 2.67 \times 10^6 (\mathrm{mm}^3)$

(4)

$i_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{3.03 \times 10^9}{4.0 \times 10^4}} = 275 (\mathrm{mm}), i_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{5.33 \times 10^8}{4.0 \times 10^4}} = 115 (\mathrm{mm})$

(c)----------

(1)

$A = 4.25 \times 10^4 (\mathrm{mm}^2)$,

$G_x = \int_0^{25} 300 y dy + \int_{25}^{575} 50 y dy + \int_{575}^{600} 300 y dy = 1.275 \times 10^7 (\mathrm{mm}^3)$,

$G_y = \int_0^{25} 600 x dx + \int_{25}^{275} 50 x dx + \int_{275}^{300} 600 x dx = 6.375 \times 10^6 (\mathrm{mm}^3)$

$x_0 = \frac{G_y}{A} = \frac{6.375 \times 10^7}{4.25 \times 10^4} = 150(\mathrm{mm}), y_0 = \frac{G_x}{A} = \frac{1.275 \times 10^4}{4.25 \times 10^4} = 300(\mathrm{mm})$

(2)

$I_X = \frac{300 \cdot 600^3}{12} - \frac{300 \cdot 550^3}{12} = 1.93 \times 10^9 (\mathrm{mm}^4), I_Y = \frac{600 \cdot 300^3}{12} - \frac{500 \cdot 250^3}{12} = 6.34 \times 10^8 (\mathrm{mm}^4)$

(3)

$Z_X = \frac{I_X}{300} = \frac{3.466 \times 10^9}{300} = 1.16 \times 10^7 (\mathrm{mm}^3), Z_Y = \frac{I_Y}{150} = \frac{6.336 \times 10^8}{150} = 4.22 \times 10^6 (\mathrm{mm}^3)$

(4)

$i_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{3.466 \times 10^9}{4.25 \times 10^4}} = 286(\mathrm{mm}), i_Y = \sqrt{\frac{I_Y}{A}} = \sqrt{\frac{6.336 \times 10^8}{4.25 \times 10^4}} = 122(\mathrm{mm})$

B 1

(a)----------

(1)

$A = 3.24 \times 10^4 (\mathrm{mm}^2)$,

$G_x = 24000 \times 300 + 8400 \times 20 = 7.368 \times 10^6 (\mathrm{mm}^3)$

$y_0 = \frac{G_x}{A} = \frac{7.368 \times 10^6}{3.24 \times 10^4} = 227(\mathrm{mm})$

(2)

$I_X = \int_{-73}^{373} 40 Y^2 dY + \int_{-73}^{-33} 210 Y^2 dY = 7.22 \times 10^8 (\mathrm{mm}^4)$

(3)

$Z_{y1} = \frac{I_X}{y_1} = \frac{7.22 \times 10^8}{73} = 9.89 \times 10^6 (\mathrm{mm}^3), Z_{y2} = \frac{I_X}{y_2} = \frac{7.22 \times 10^8}{373} = 2.65 \times 10^4 (\mathrm{mm}^3)$

(4)

$i_X = \sqrt{\frac{I_X}{A}} = \sqrt{\frac{7.22 \times 10^8}{3.24 \times 10^4}} = 149(\mathrm{mm})$

(b)----------

(1)

$A = 2.60 \times 10^4 (\mathrm{mm}^2)$,

$G_x = \int_0^{40} 200ydy + \int_{40}^{340} 40ydy + \int_{340}^{360} 300ydy = 4.54 \times 10^6 (\mathrm{mm}^3)$

$y_0 = \dfrac{G_x}{A} = \dfrac{4.54 \times 10^6}{2.6 \times 10^4} = 174 (\mathrm{mm})$

(2)

$I_X = \int_{165}^{185} 300Y^2 dY + \int_{-135}^{165} 40Y^2 dY + \int_{-175}^{-135} 200Y^2 dY = 2.96 \times 10^8 (\mathrm{mm}^4)$ 4.70

(3)

$Z_{y1} = \dfrac{I_X}{y_1} = \dfrac{2.96 \times 10^8}{175} = 1.69 \times 10^6 (\mathrm{mm}^3)$, $Z_{y2} = \dfrac{I_X}{y_2} = \dfrac{2.96 \times 10^8}{185} = 1.60 \times 10^6 (\mathrm{mm}^3)$

4.70 2.69 4.70 2.54

(4)

$i_X = \sqrt{\dfrac{I_X}{A}} = \sqrt{\dfrac{2.96 \times 10^8}{2.6 \times 10^4}} = 107 (\mathrm{mm})$

4.70 134

(c)----------

(1) $A = 3.00 \times 10^5 (\mathrm{mm}^2)$, 8.75×10⁴

上下対称なので，$y_0 = 600 (\mathrm{mm}^3)$

$\int_{-600}^{600} 625Y^2 dY - 2\int_{-575}^{575} 275Y^2 dY - 2\int_{-300}^{300} 25Y^2 dY$

(2)

$I_X = \dfrac{625 \cdot 1200^3}{12} - 2 \times \dfrac{300 \cdot 1150^3}{12} - 2 \times \dfrac{25 \cdot 600^3}{12} = 1.31 \times 10^{10} (\mathrm{mm}^4)$

$= 1.94 \times 10^{10} (\mathrm{mm}^4)$

(3)

$Z_{y1} = Z_{y2} = \dfrac{I_X}{y_1} = \dfrac{1.31 \times 10^{10}}{600} = 2.18 \times 10^7 (\mathrm{mm}^3)$

1.94 3.23

(4)

$i_X = \sqrt{\dfrac{I_X}{A}} = \sqrt{\dfrac{1.31 \times 10^{10}}{3.00 \times 10^5}} = 7.27 \times 10^1 (\mathrm{mm})$

1.94 8.75×10⁴ 471