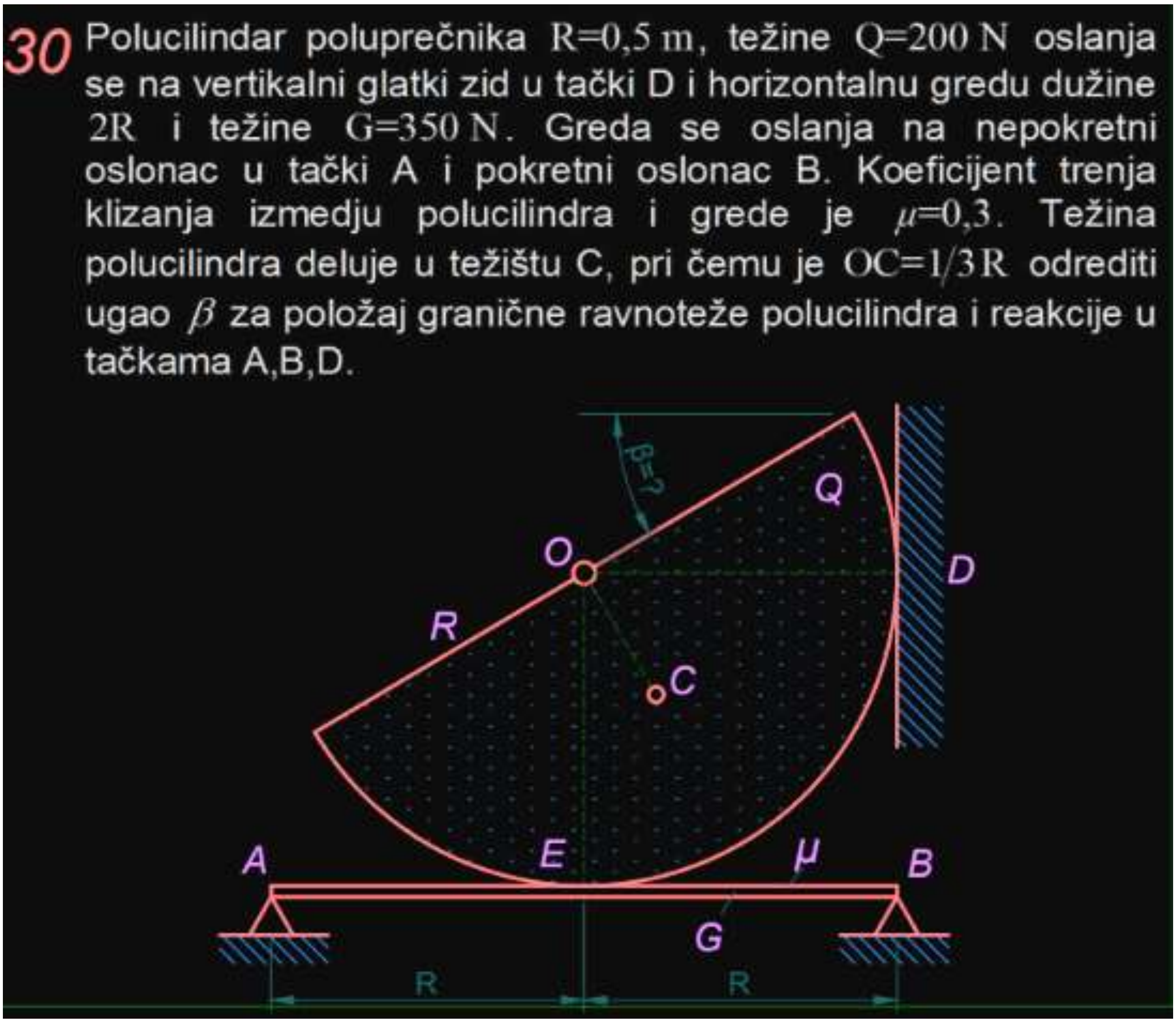
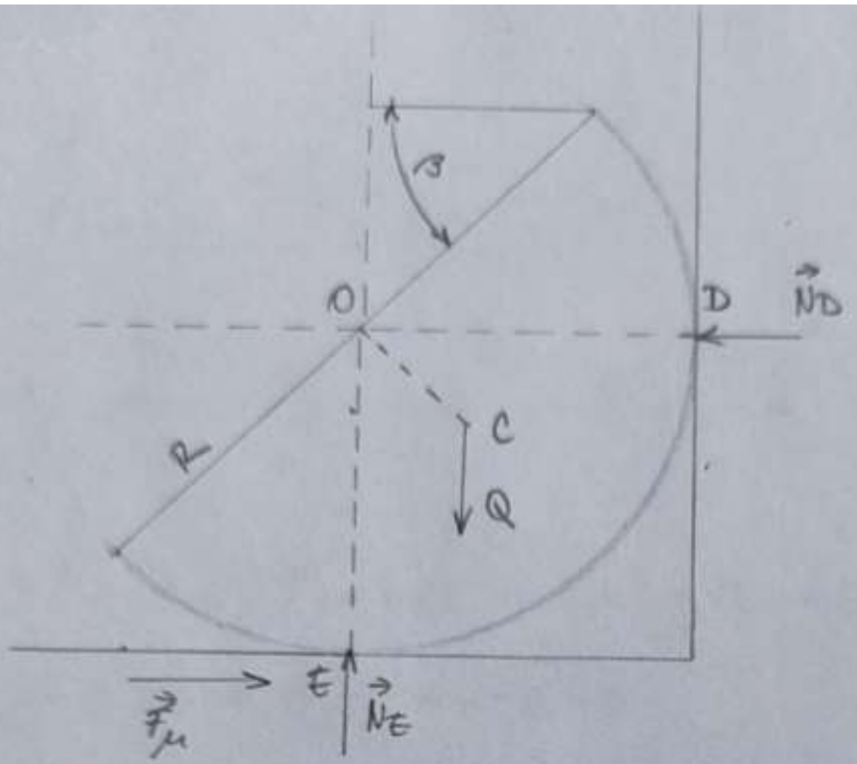
TEHNIČKA MEHANIKA 1 – GRAFIČKI RADOVI



30 Polucilindar poluprečnika $R=0{,}5\ \mathrm{m}$, težine $Q=200\ \mathrm{N}$ oslanja se na vertikalni glatki zid u tački D i horizontalnu gredu dužine $2R$ i težine $G=350\ \mathrm{N}$. Greda se oslanja na nepokretni oslonac u tački A i pokretni oslonac B. Koeficijent trenja klizanja izmedju polucilindra i grede je $\mu=0{,}3$. Težina polucilindra deluje u težištu C, pri čemu je $OC=1/3R$ odrediti ugao β za položaj granične ravnoteže polucilindra i reakcije u tačkama A,B,D.



$$\Sigma X_i = F_\mu - N_D = 0 \Rightarrow F_\mu = N_D$$

$$\Sigma Y_i = Q - N_E = 0 \Rightarrow Q = N_E$$

$$\Sigma M_O = F_\mu \cdot R - \frac{4R}{3\pi} \cdot Q \cdot \sin\beta = 0$$

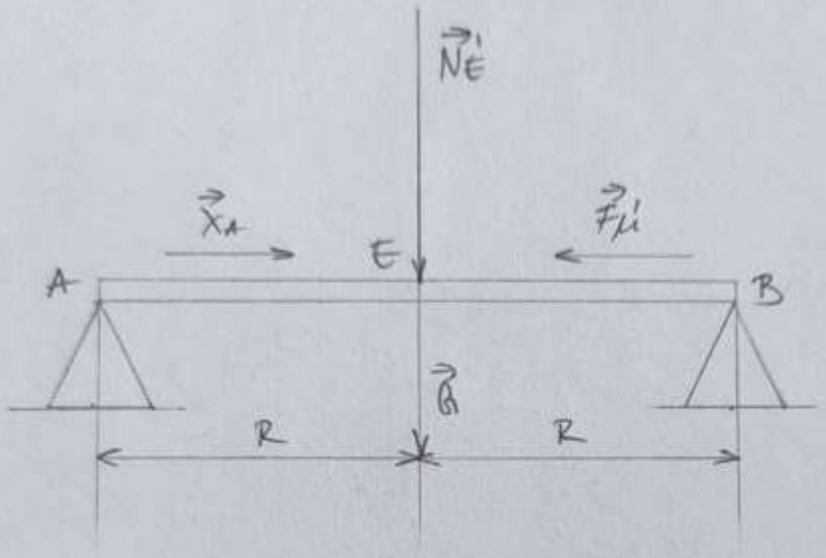
$$F_\mu = \mu N_E = 0{,}3 \cdot 200\,N = 60N$$

$$F_\mu = N_D = 60\,N$$

$$F_\mu \cdot \cancel{R} = \frac{4}{3} Q \cdot \cancel{R} \sin\beta$$

$$\sin\beta = \frac{3F_\mu}{4Q} = \frac{180N}{800N} = 0{,}225$$

$$\beta = 13^\circ \qquad \sin\beta = 0{,}225$$



$$\Sigma X_i = X_A - F'_\mu = 0 \Rightarrow X_A = F'_\mu = 60\,N$$

$$\Sigma Y_i = N'_E + G - F_A - F_B = 0$$

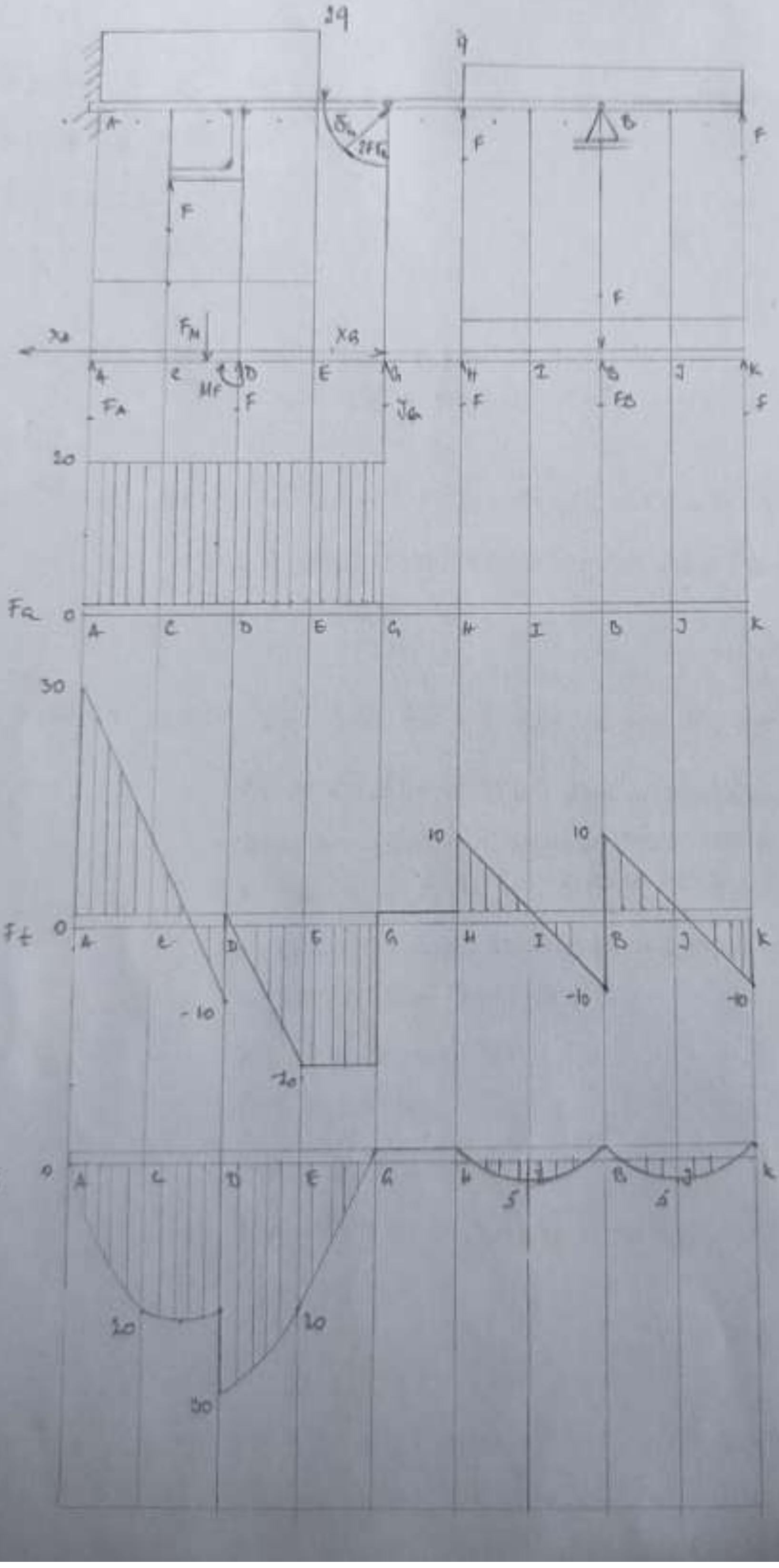
$$\Sigma M_A = F_B \cdot 2R - GR - N'_E R$$

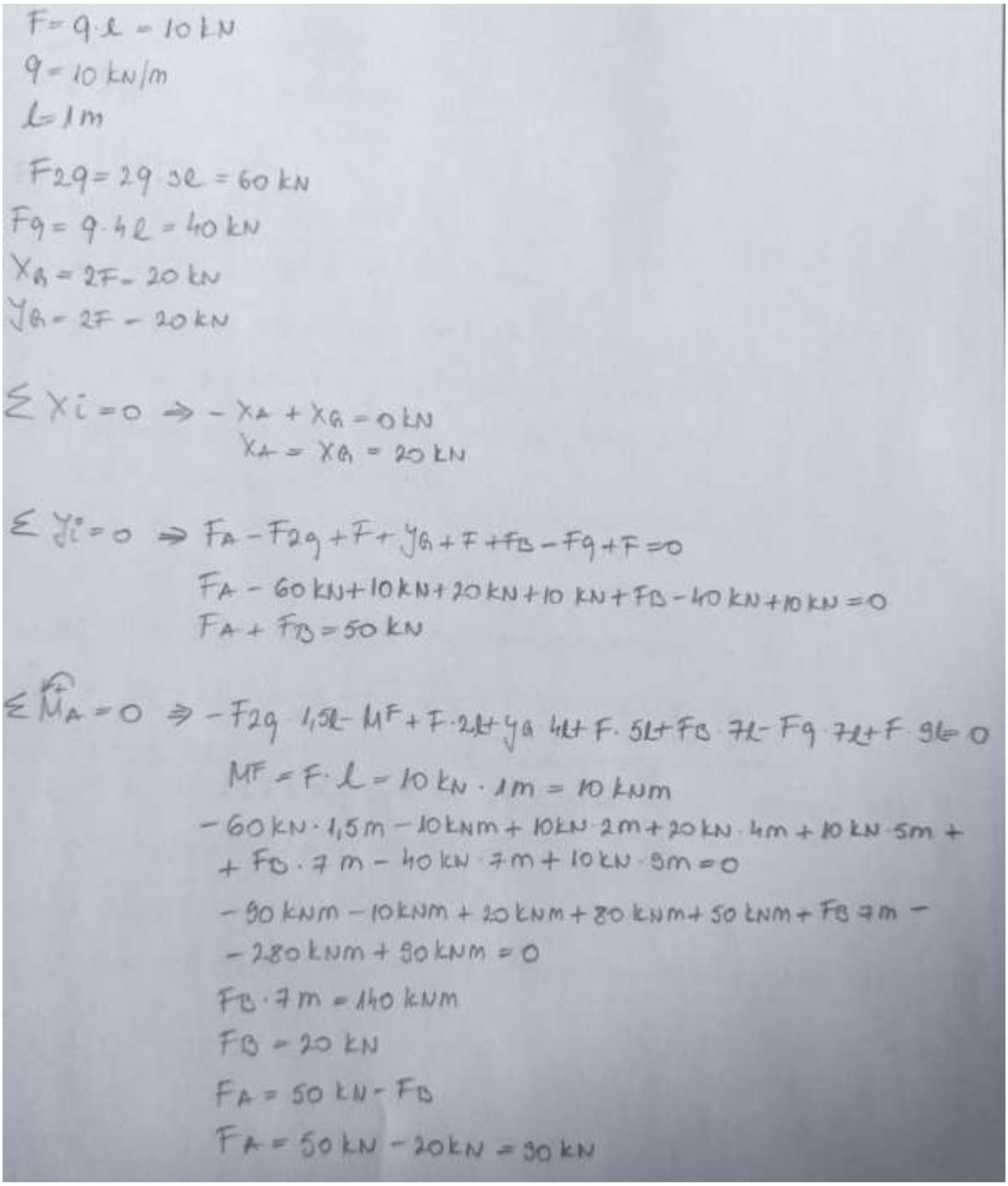
$$F_B \cdot 2\cancel{R} = G\cancel{R} + N'_E R$$

$$F_B = \frac{G + N'_E}{2} = \frac{360N + 200N}{2} = 275\,N$$

$$N'_E + G = F_A + F_B = 275 \cdot N$$

30. За дати Герберов носач одредити реакције веза и нацртати основне статичке дијаграме. Познато је $m = 2ql^2$; $F = q \cdot l$; $q = 10\ kN/m$; $l = 1m$





$F = q \cdot l = 10\ kN$

$q = 10\ kN/m$

$l = 1\ m$

$F_{2q} = 2q \cdot 3l = 60\ kN$

$F_q = q \cdot 4l = 40\ kN$

$X_G = 2F = 20\ kN$

$Y_G = 2F = 20\ kN$

$\sum X_i = 0 \Rightarrow -X_A + X_G = 0\ kN$

$X_A = X_G = 20\ kN$

$\sum Y_i = 0 \Rightarrow F_A - F_{2q} + F + Y_G + F + F_B - F_q + F = 0$

$F_A - 60\ kN + 10\ kN + 20\ kN + 10\ kN + F_B - 40\ kN + 10\ kN = 0$

$F_A + F_B = 50\ kN$

$\sum \overset{\curvearrowleft +}{M_A} = 0 \Rightarrow -F_{2q} \cdot 1{,}5l - M^F + F \cdot 2l + Y_G \cdot 4l + F \cdot 5l + F_B \cdot 7l - F_q \cdot 7l + F \cdot 9l = 0$

$M^F = F \cdot l = 10\ kN \cdot 1\ m = 10\ kNm$

$-60\ kN \cdot 1{,}5\ m - 10\ kNm + 10\ kN \cdot 2\ m + 20\ kN \cdot 4\ m + 10\ kN \cdot 5\ m +$
$+ F_B \cdot 7\ m - 40\ kN \cdot 7\ m + 10\ kN \cdot 9\ m = 0$

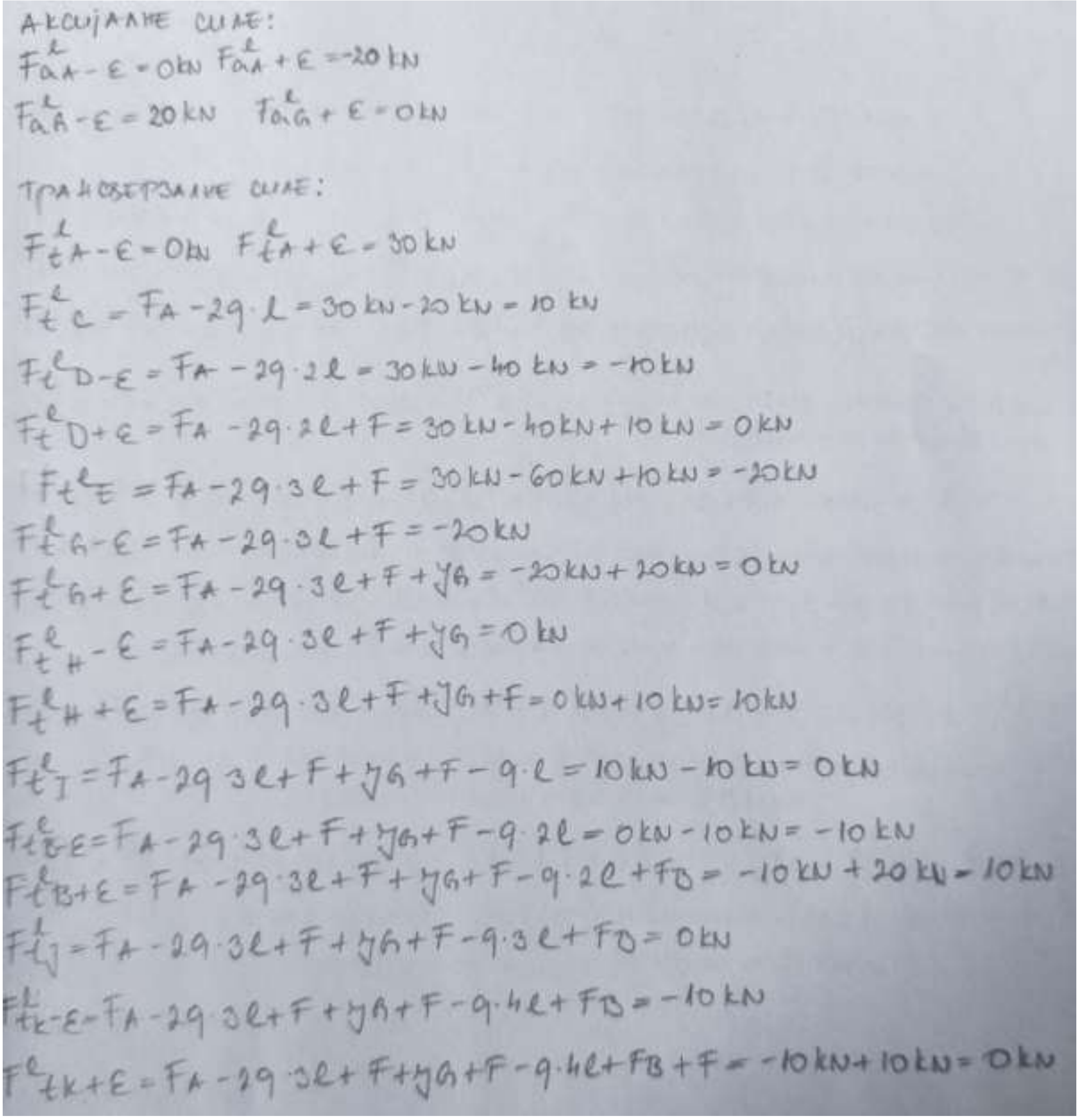
$-90\ kNm - 10\ kNm + 20\ kNm + 80\ kNm + 50\ kNm + F_B\ 7\ m -$
$- 280\ kNm + 90\ kNm = 0$

$F_B \cdot 7\ m = 140\ kNm$

$F_B = 20\ kN$

$F_A = 50\ kN - F_B$

$F_A = 50\ kN - 20\ kN = 30\ kN$



АКСИЈАЛНЕ СИЛЕ:

$F_{aA-\varepsilon}^{l} = 0\,kN$ $F_{aA+\varepsilon}^{l} = -20\,kN$

$F_{aB-\varepsilon}^{l} = 20\,kN$ $F_{aG+\varepsilon}^{l} = 0\,kN$

ТРАНСВЕРЗАЛНЕ СИЛЕ:

$F_{tA-\varepsilon}^{l} = 0\,kN$ $F_{tA+\varepsilon}^{l} = 30\,kN$

$F_{tC}^{l} = F_A - 2q\cdot l = 30\,kN - 20\,kN = 10\,kN$

$F_{tD-\varepsilon}^{l} = F_A - 2q\cdot 2l = 30\,kN - 40\,kN = -10\,kN$

$F_{tD+\varepsilon}^{l} = F_A - 2q\cdot 2l + F = 30\,kN - 40\,kN + 10\,kN = 0\,kN$

$F_{tE}^{l} = F_A - 2q\cdot 3l + F = 30\,kN - 60\,kN + 10\,kN = -20\,kN$

$F_{tG-\varepsilon}^{l} = F_A - 2q\cdot 3l + F = -20\,kN$

$F_{tG+\varepsilon}^{l} = F_A - 2q\cdot 3l + F + y_G = -20\,kN + 20\,kN = 0\,kN$

$F_{tH-\varepsilon}^{l} = F_A - 2q\cdot 3l + F + y_G = 0\,kN$

$F_{tH+\varepsilon}^{l} = F_A - 2q\cdot 3l + F + y_G + F = 0\,kN + 10\,kN = 10\,kN$

$F_{tI}^{l} = F_A - 2q\,3l + F + y_G + F - q\cdot l = 10\,kN - 10\,kN = 0\,kN$

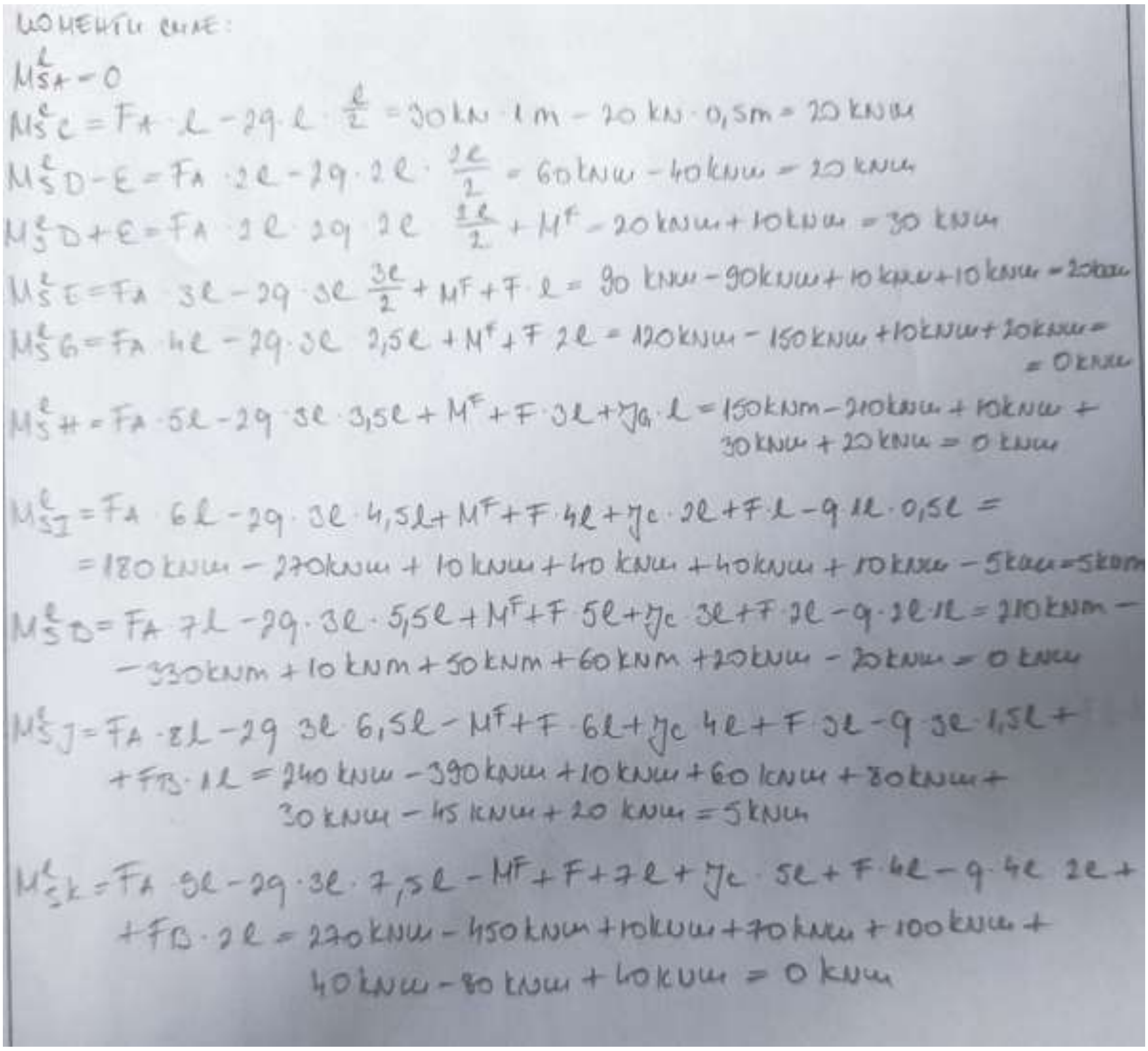
$F_{tB-\varepsilon}^{l} = F_A - 2q\cdot 3l + F + y_G + F - q\cdot 2l = 0\,kN - 10\,kN = -10\,kN$

$F_{tB+\varepsilon}^{l} = F_A - 2q\cdot 3l + F + y_G + F - q\cdot 2l + F_B = -10\,kN + 20\,kN = 10\,kN$

$F_{tJ}^{l} = F_A - 2q\cdot 3l + F + y_G + F - q\cdot 3l + F_B = 0\,kN$

$F_{tK-\varepsilon}^{l} = F_A - 2q\,3l + F + y_G + F - q\cdot 4l + F_B = -10\,kN$

$F_{tK+\varepsilon}^{l} = F_A - 2q\,3l + F + y_G + F - q\cdot 4l + F_B + F = -10\,kN + 10\,kN = 0\,kN$



МОМЕНТИ СИЛЕ:

$M^l_{SA} = 0$

$M^l_{SC} = F_A \cdot l - 2q \cdot l \cdot \frac{l}{2} = 30\,kN \cdot 1m - 20\,kN \cdot 0{,}5m = 20\,kNm$

$M^l_{SD-E} = F_A \cdot 2l - 2q \cdot 2l \cdot \frac{2l}{2} = 60\,kNm - 40\,kNm = 20\,kNm$

$M^l_{SD+E} = F_A \cdot 2l \cdot 2q \cdot 2l \cdot \frac{2l}{2} + M^F = 20\,kNm + 10\,kNm = 30\,kNm$

$M^l_{SE} = F_A \cdot 3l - 2q \cdot 3l \cdot \frac{3l}{2} + M^F + F \cdot l = 90\,kNm - 90\,kNm + 10\,kNm + 10\,kNm = 20\,kNm$

$M^l_{SG} = F_A \cdot 4l - 2q \cdot 3l \cdot 2{,}5l + M^F + F \cdot 2l = 120\,kNm - 150\,kNm + 10\,kNm + 20\,kNm =$
$= 0\,kNm$

$M^l_{SH} = F_A \cdot 5l - 2q \cdot 3l \cdot 3{,}5l + M^F + F \cdot 3l + Y_G \cdot l = 150\,kNm - 210\,kNm + 10\,kNm +$
$30\,kNm + 20\,kNm = 0\,kNm$

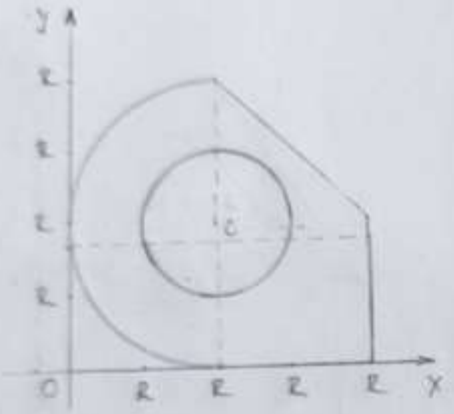
$M^l_{SI} = F_A \cdot 6l - 2q \cdot 3l \cdot 4{,}5l + M^F + F \cdot 4l + Y_C \cdot 2l + F \cdot l - q \cdot 1l \cdot 0{,}5l =$
$= 180\,kNm - 270\,kNm + 10\,kNm + 40\,kNm + 40\,kNm + 10\,kNm - 5\,kNm = 5\,kNm$

$M^l_{SB} = F_A \cdot 7l - 2q \cdot 3l \cdot 5{,}5l + M^F + F \cdot 5l + Y_C \cdot 3l + F \cdot 2l - q \cdot 2l \cdot 1l = 210\,kNm -$
$- 330\,kNm + 10\,kNm + 50\,kNm + 60\,kNm + 20\,kNm - 20\,kNm = 0\,kNm$

$M^l_{SJ} = F_A \cdot 8l - 2q \cdot 3l \cdot 6{,}5l - M^F + F \cdot 6l + Y_C \cdot 4l + F \cdot 3l - q \cdot 3l \cdot 1{,}5l +$
$+ F_B \cdot 1l = 240\,kNm - 390\,kNm + 10\,kNm + 60\,kNm + 80\,kNm +$
$30\,kNm - 45\,kNm + 20\,kNm = 5\,kNm$

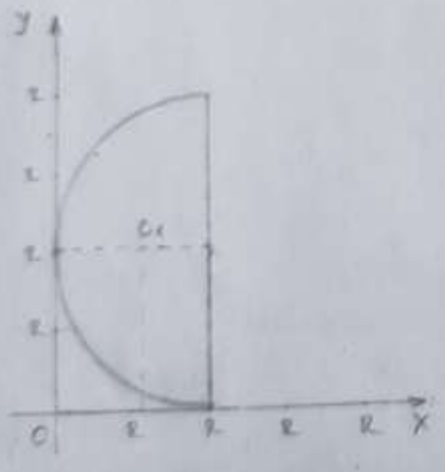
$M^l_{SK} = F_A \cdot 9l - 2q \cdot 3l \cdot 7{,}5l - M^F + F + 7l + Y_C \cdot 5l + F \cdot 4l - q \cdot 4l \cdot 2l +$
$+ F_B \cdot 2l = 270\,kNm - 450\,kNm + 10\,kNm + 70\,kNm + 100\,kNm +$
$40\,kNm - 80\,kNm + 40\,kNm = 0\,kNm$

30. ОДРЕДИТИ ТЕЖИШТЕ ОЗНАЧЕНЕ ПОВРШИНЕ АНАЛИТИЧКИМ ПУТЕМ И ИЗРАЧУНАТИ ЗАПРЕМИНУ КОЈА НАСТАЈЕ РОТАЦИЈОМ ДАТЕ ПОВРШИ ОКО Ox и Oy ОСЕ (R=1cm).

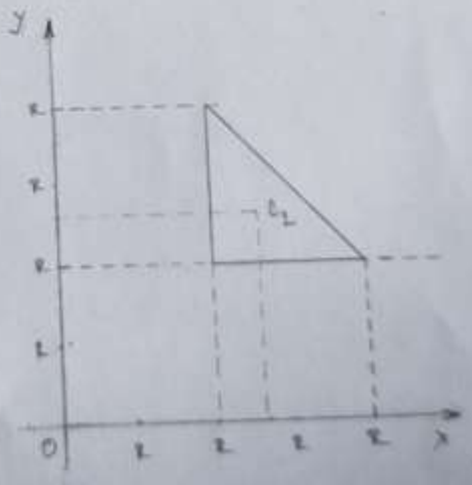


R=1cm

1)



2)



C_1: $x_1 = 2R - \frac{4}{3}\cdot\frac{2R}{\pi}$

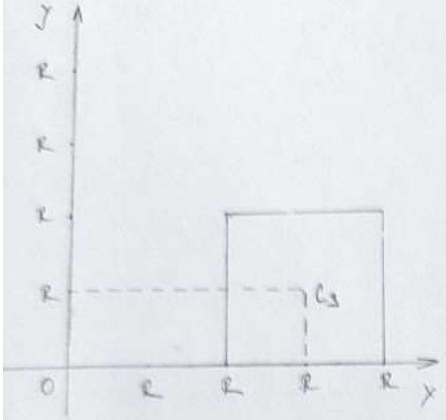
$x_1 = 2R\left(1 - \frac{4}{3\pi}\right)$

$y_1 = 2R$

C_2: $x_2 = 2R + \frac{1}{3}2R = \frac{8}{3}R$

$y_2 = 2R + \frac{1}{3}2R = \frac{8}{3}R$

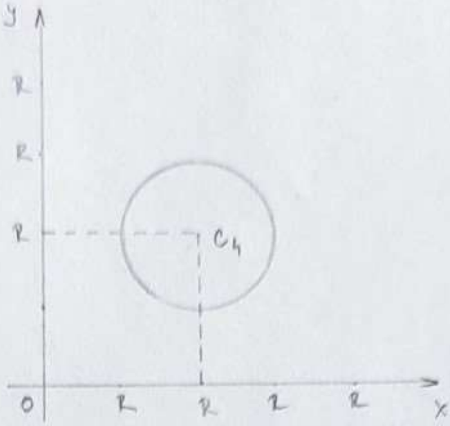
3)



C_3: $x_3 = 3R$

$y_3 = R$

4)



C_4: $x_4 = 2R$

$y_4 = 2R$

Ai[cm²]		Xi [cm]		yi [cm]		AiXi	Aiyi
1. $2R^2\pi$	6,28	$2R(1-\frac{4}{3\pi})$	1,15	2R	2	7,22	12,56
2. $2R^2$	2	$\frac{8}{3}R$	2,67	$\frac{8}{3}R$	2,67	5,34	5,34
3 $4R^2$	4	3R	3	R	1	12	4
4. $-R^2\pi$	-3,14	2R	2	2R	2	-6,28	-6,28
	Σ 9,14					Σ 18,282	Σ 15,62

$$x_c = \frac{\Sigma A_i x_i}{A} = 2{,}00 \text{ cm}$$

$$y_c = \frac{\Sigma A_i y_i}{A} = 1{,}71 \text{ cm}$$

$$V_x = 2\pi y_c A = 2 \cdot 3{,}14 \cdot 1{,}71 \text{cm} \quad 9{,}14 \text{ cm}^2 = 98{,}09 \text{ cm}^3$$

$$V_y = 2\pi x_c A = 2 \cdot 3{,}14 \cdot 2{,}00 \text{cm} \quad 9{,}14 \text{ cm}^2 = 114{,}81 \text{ cm}^3$$