Robt 304 Zarema Balgabekova HW4

4.1

$p = 6$

$n = 1200$ rev/min

a) $f_m = \frac{n}{60} = \frac{1200}{60} = 20$ [Hz]

$\omega_m = 2\pi f_m = 2\pi \cdot 20 = 40\pi$ [rad/s]

b) $f_e = \frac{poles}{2} \cdot \frac{n}{60} = \frac{6}{2} \cdot \frac{1200}{60} = 60$ [Hz]

$\omega_e = \frac{poles}{2} \omega_m = \frac{6}{2} \cdot 40\pi = 120\pi$ [rad/s]

c) $f_e = 50$ Hz

$f_e = \frac{poles}{2} \cdot \frac{n}{60} = 50$

$n = \frac{50 \cdot 120}{poles} = \frac{50 \cdot 120}{6} = 1000$ [rev/min]

4.2 In one phase, $v(t) = V_0 \cos \omega t$

As three coils are displaced at $120°$, generated voltages will also be out of phase of exactly $120°$.

$\Rightarrow$ Voltages in the remaining two phases:

$$v(t) = V_0 \cos(\omega t - 120°)$$

$$v(t) = V_0 \cos(\omega t + 120°)$$

4.3

a) Induction because the speed of the motor decreases when the pump is loaded. The rotor of the induction motor rotates at slightly lower speed, The synchronous motor rotates at a constant speed.

b) Typically, $f_e = 50$ or 60 Hz

We know that $f_e = \frac{poles}{2} \cdot \frac{n}{60} = \frac{898}{120}$ poles

If $f_e = 50$ Hz, $poles = \frac{120 \cdot 50}{898} = 6.68$

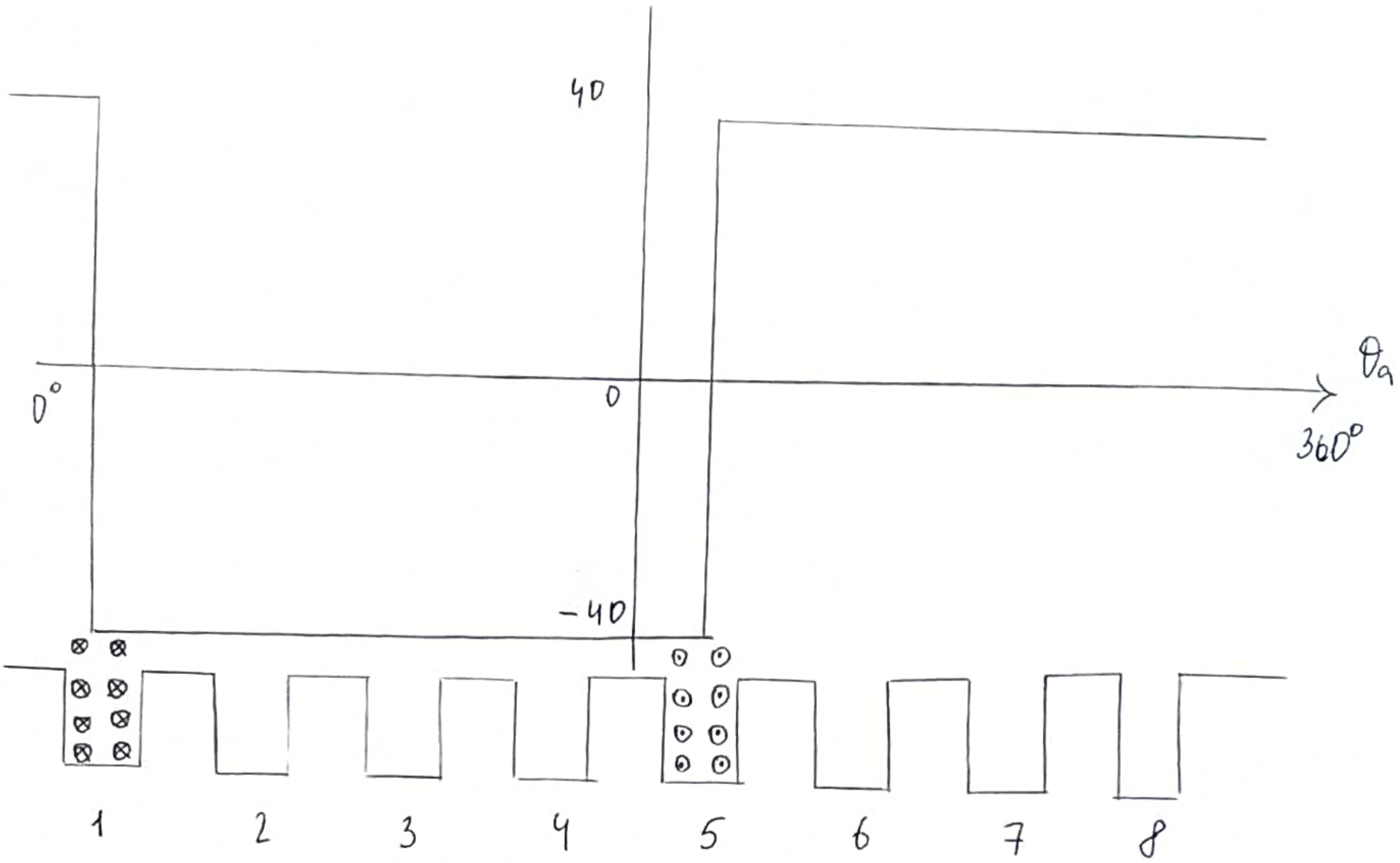
If $f_e = 60$ Hz, $poles = \frac{120 \cdot 60}{898} \approx 8$

As 8 poles is more practical, $f_e = 60$ Hz

c) From b, poles = 8.

4.4

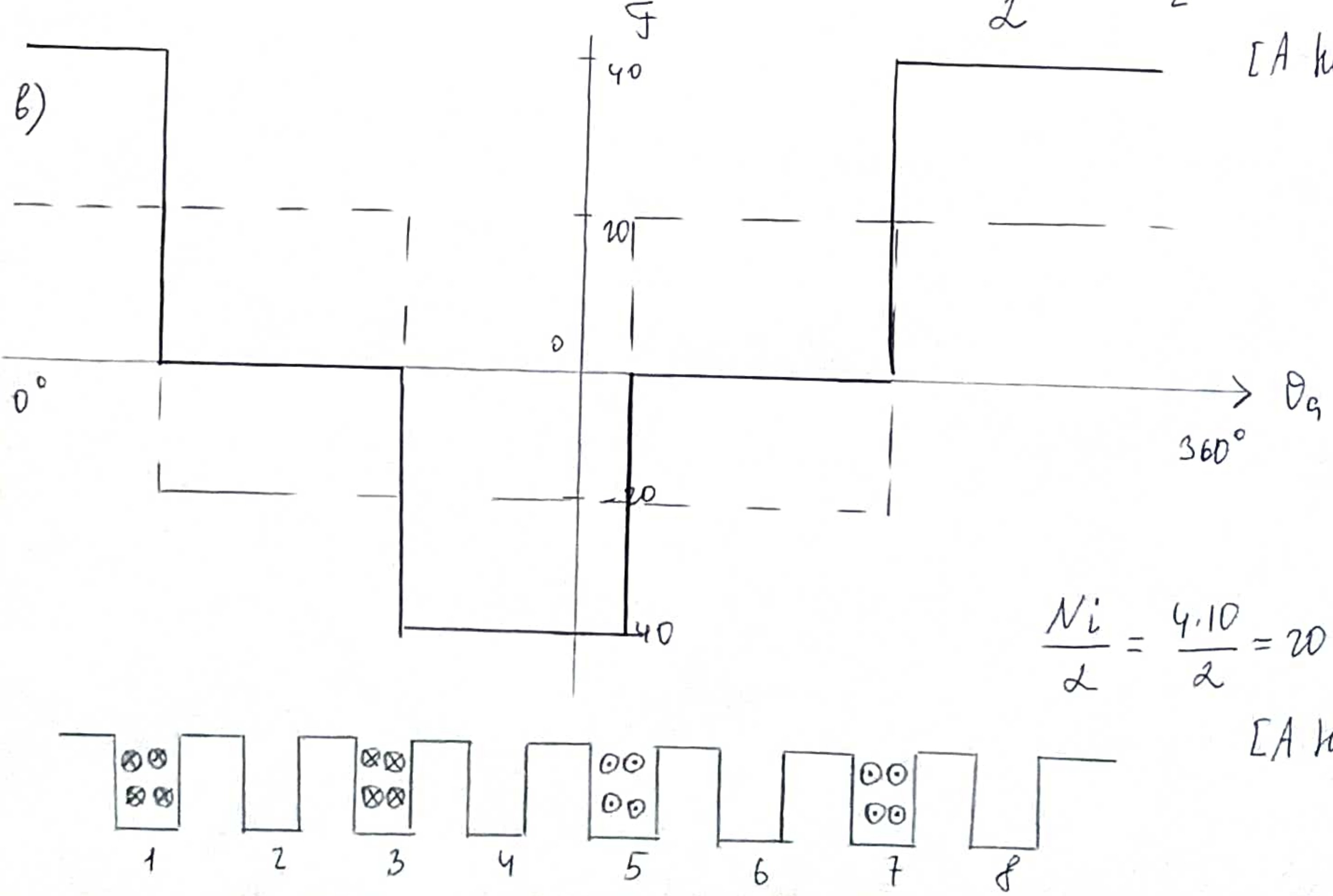
a)



Amplitude of rectangular mmf wave $\frac{Ni}{2} = \frac{8 \cdot 10}{2} = 40$

[A turn]

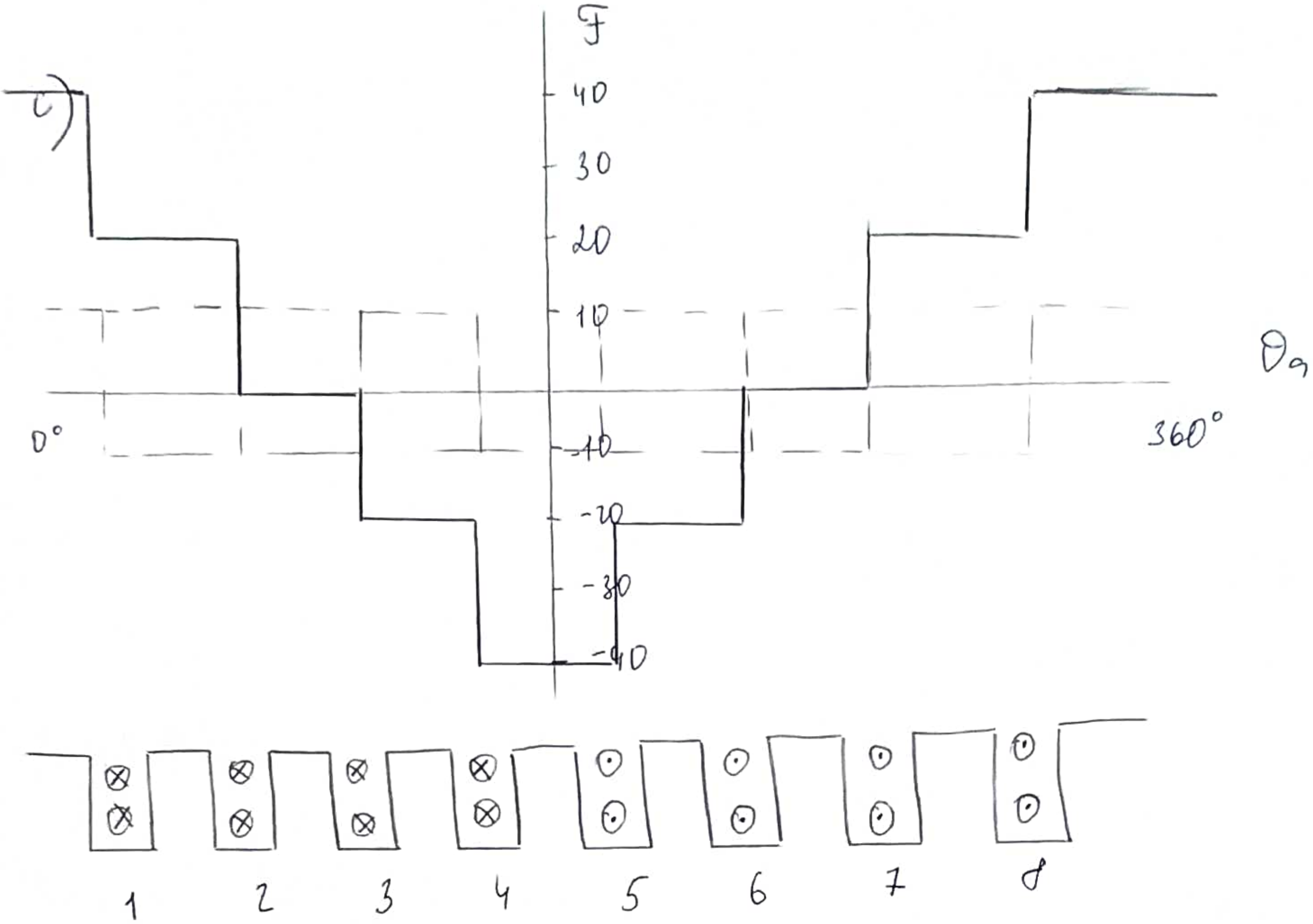
b)



$\frac{Ni}{2} = \frac{4 \cdot 10}{2} = 20$

[A turn]

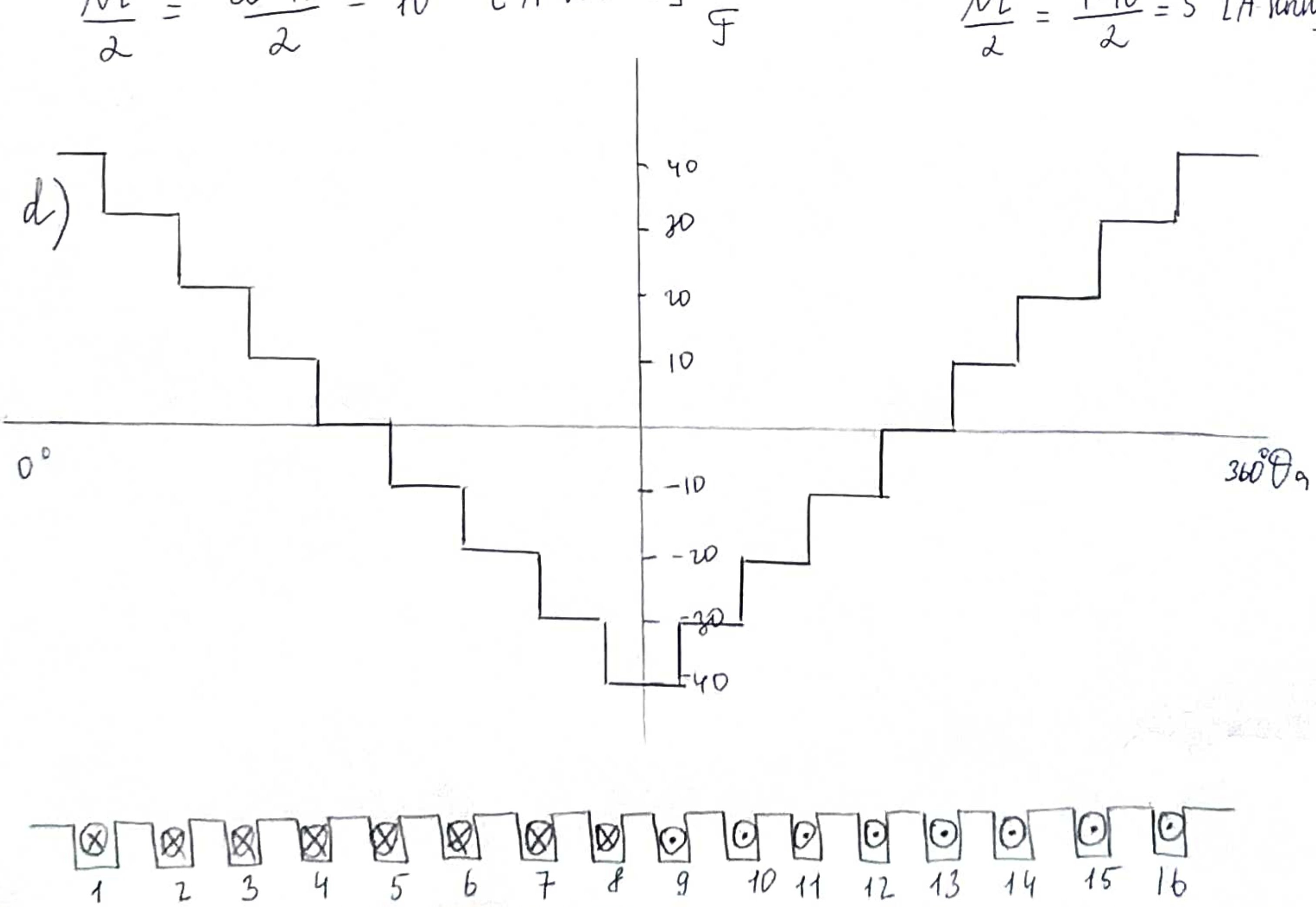
c)



$$\frac{Ni}{2} = \frac{2 \cdot 10}{2} = 10 \quad [A\ turns]$$

$$\frac{Ni}{2} = \frac{1 \cdot 10}{2} = 5\ [A\ turns]$$

d)



4.9 poles = 6 $\qquad k_r = 0.935 \qquad g = 3.15$ cm

$f_e = 60$ Hz $\qquad L = 1.97$ m

$N_r = 138 \qquad R = 58$ cm

a) $$f_e = \frac{poles}{2}\frac{n}{60}$$

$$n = \frac{120 f_e}{poles} = \frac{120 \cdot 60}{6} = 1200 \text{ [rev/min]}$$

b) $(B_g)_{peak} = 1.23$ T

$$(B_g)_{peak} = \mu_0 (H_g)_{peak} = \frac{\mu_0 (\mathcal{F}_g)_{peak}}{g}$$ (Ampere's law)

$$(B_g)_{peak} = \frac{\mu_0}{g}\frac{4}{\pi}\frac{k_r N_r I_r}{poles}$$

$$\Rightarrow I_r = \frac{g \pi \cdot poles \cdot (B_g)_{peak}}{\mu_0 \cdot 4 \, k_r N_r} =$$

$$\frac{3.15\ 10^{-2} \cdot \cancel{\pi} \cdot 6 \cdot 1.23}{4\cancel{\pi} \cdot 10^{-7} \cdot 4 \cdot 0.935 \cdot 138} = 1126\ [A]$$

c) φ_{pole} = (average value of B over a pole)·(Area pole) =

$$\frac{2}{\cancel{\pi}} (B_g)_{peak} \cdot \frac{2\cancel{\pi} R L}{poles} = \frac{4}{6} \cdot 1.23 \cdot 58 \cdot 10^{-2} \cdot 1.97$$

$$= 0.937\ [Wb]$$