PRIPREMA ZA 2. MEĐUISPIT

MASOVNE INSTRUKCIJE

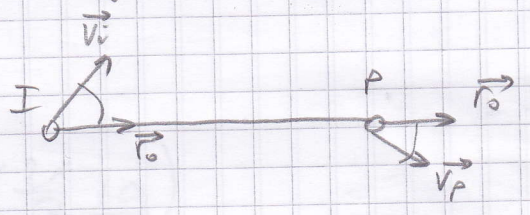
DOPPLEROV EFEKT

$$f' = f \frac{v - \vec{r}_0 \cdot \vec{v}_P}{v - \vec{r}_0 \cdot \vec{v}_i}$$

f' – frekv. prijemnika; f – frekv. izvora; $\vec{v}_P$ – brzina prijemnika; $\vec{v}_i$ – brzina izvora

$\vec{r}_0$ – jedin. vektor od izvora prema prijemniku

$$\vec{r}_0 \cdot \vec{v}_{P/i} = |\vec{r}_0| \cdot |\vec{v}_{P/i}| \cdot \cos(\vec{r}_0, \vec{v}_{P/i})$$



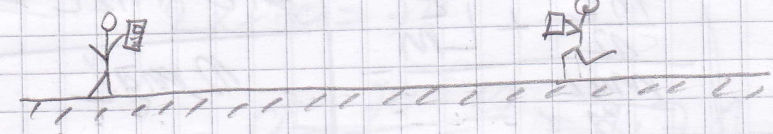
$$f' = f \sqrt{\frac{1+b}{1-b}}, \quad b = \frac{v}{c}$$

1.

$v_i = 18\,km/h = 5\,m/s$

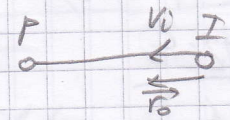
$v_{zvuka} = 340\,m/s$

a)



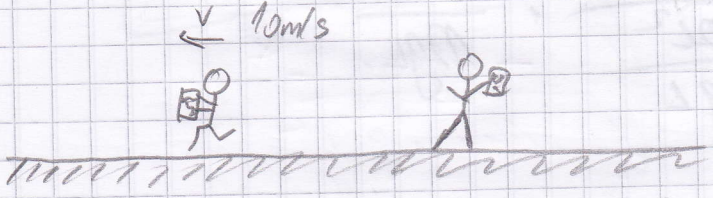
$v_P = 0$

$\gamma = 0°$

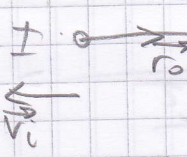


$$f' = f \frac{v - \vec{r}_0 \cdot \vec{v}_P}{v - \vec{r}_0 \cdot \vec{v}_i} = 1000 \cdot \frac{340 - 0}{340 - |\vec{r}_0||\vec{v}_i| \cdot \cos\gamma} = 1000 \frac{340}{340 - 5} = 1014{,}92\,Hz$$

b)



$$f' = 1000 \frac{v - \vec{r}_0 \cdot \vec{v}_P}{v - \vec{r}_0 \cdot \vec{v}_i}$$

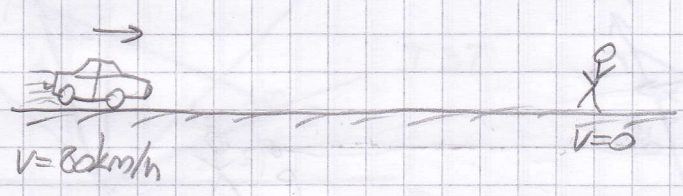


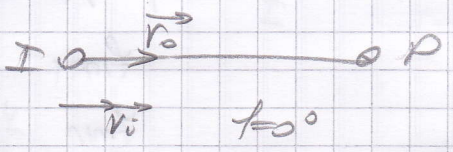
$\gamma = 180°$

$$= 1000 \cdot \frac{340}{340 - |\vec{r}_0||\vec{v}_i| \cdot \cos\gamma} = 1000 \frac{340}{340 + 10} = 971{,}42\,m/s$$

(2)

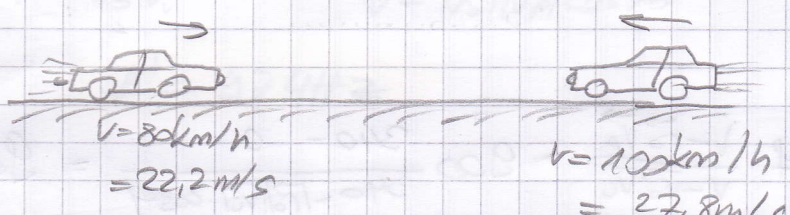
a)

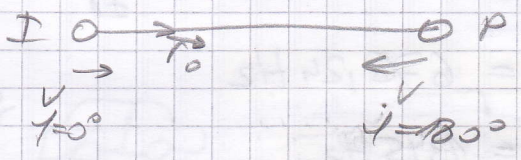




$$f' = f\,\frac{v-\vec{r}_0\vec{v}_p}{v-\vec{r}_0\vec{v}_i} = 1500\,\frac{340}{340-|\vec{r}_0||\vec{v}_i|\cos\varphi} = \frac{340}{340-22{,}2}\cdot 1500 = 1604\,Hz$$

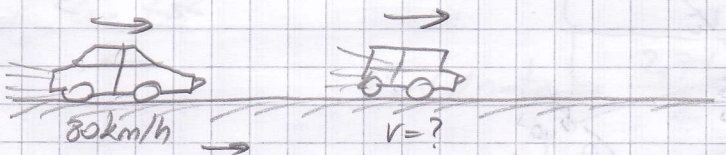
b)

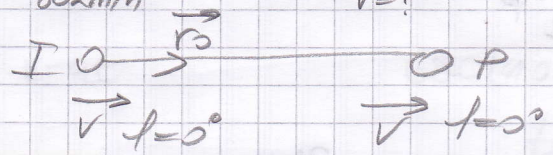




$$f' = f\cdot\frac{v-\vec{r}_0\cdot\vec{v}_p}{v-\vec{r}_0\cdot\vec{v}_i} = 1500\cdot\frac{v-|\vec{r}_0||\vec{v}_p|\cos 180°}{v-|\vec{r}_0||\vec{v}_i|\cos 0°} = 1500\,\frac{340+27{,}8}{340-22{,}2} = 1736\,Hz$$

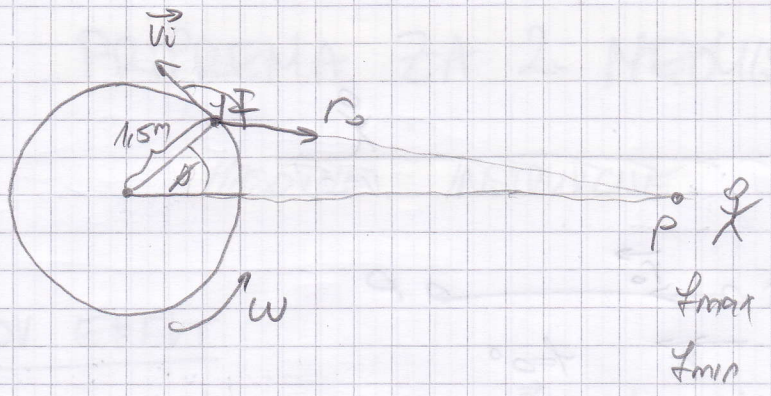
c)





$$1505 = 1500\,\frac{340-\vec{v}_p}{340-22{,}2} \quad\Rightarrow\quad v_p = 21{,}6\ m/s$$

3.



$f = 900\,Hz$

$l = 1{,}5\,m$

$\omega = 75\,rad/s$

$f_{max}, f_{min} = ?$

$v = \omega r$

$\left(\varphi = \omega t \quad (\varphi = 90 + \varphi)\right)$

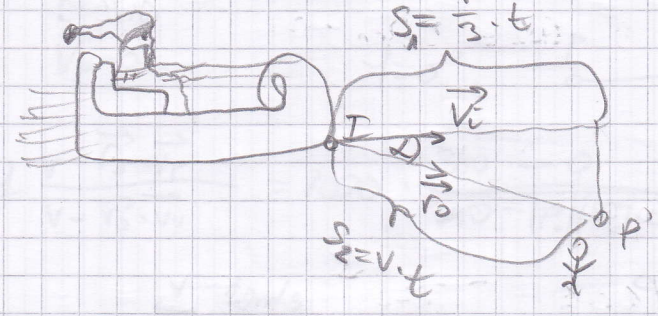
$$f' = f\,\frac{v - \vec{r_0}\vec{v_p}}{v - \vec{r_0}\vec{v_i}} \qquad -900\,\frac{340 - 0}{340 - |\vec{r_0}||\vec{v_i}|\cdot\underbrace{\cos\varphi}_{\pm 1}} = 900\,\frac{340}{340 \pm v_i}$$

$f_{min} = 676{,}24\,Hz$

$v = \omega r = 112{,}5\,m/s$

$f_{max} = 1345\,Hz$

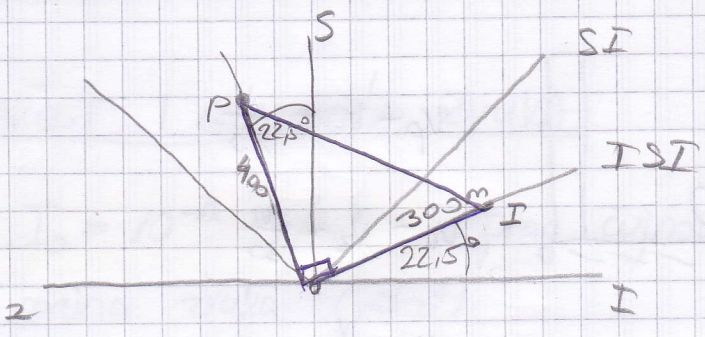
4.

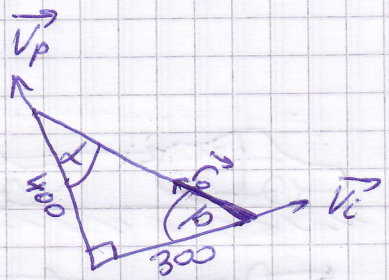


$$\cos\alpha = \frac{s_1}{s_2} = \frac{1}{3}$$

$$f' = f\,\frac{v - \vec{r_0}\cdot\vec{v_p}}{v - \vec{r_0}\cdot\vec{v_i}} = 200\,\frac{340}{340 - 114\cdot\cos\alpha} = 200\,\frac{340}{340 - 114\cdot\frac{1}{3}} = 225{,}16\,Hz$$

5.





$tg\beta = \frac{400}{300} = \frac{4}{3}$

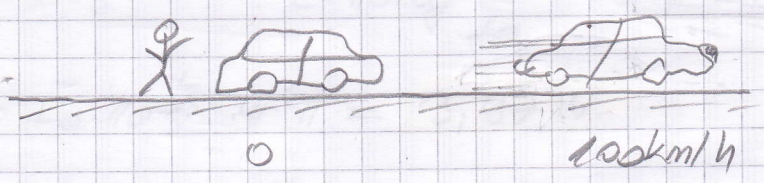
$v_{zraka\ u\ vodi} = 1450 m/s$

$\beta = 53°$ $\quad \alpha = 37°$

$$f' = f \frac{v - \vec{v_0}\vec{v_p}}{v - \vec{v_0}\vec{v_i}} = f \frac{v - |\vec{v_0}||\vec{v_p}|\cos\alpha}{v - |\vec{v_0}||\vec{v_p}|\cos\beta} = 1020 \frac{1450 - 50 \cdot 37}{1450 - 30 \cdot 53}$$

$f' = 974 Hz$

6.



$t_{zraka} + t_{zvuka} = 10s$

$a = \frac{\Delta v}{\Delta t} = 2,7 m/s^2$

$s_1 = s_2$

$v_2 \cdot t_2 = \frac{a \cdot t_a}{2}$

$340(10 - t_a) = \frac{2,7 t_a^2}{2}$

$a = \frac{v}{t} \rightarrow v = at$

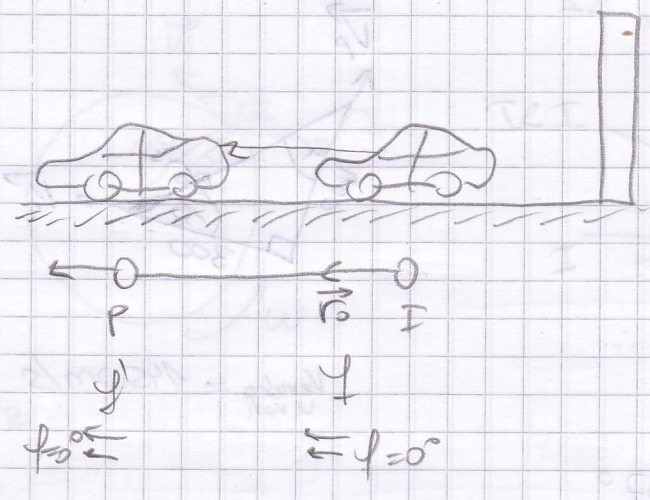
$680(10 - t_a) = 2,7 t_a^2$

$t_a = 3,63s$

$v_a = a t_a = 2,7 \cdot 3,63 = 26 m/s$

7.

a)



$$v_p - v_i = \frac{v}{10}$$

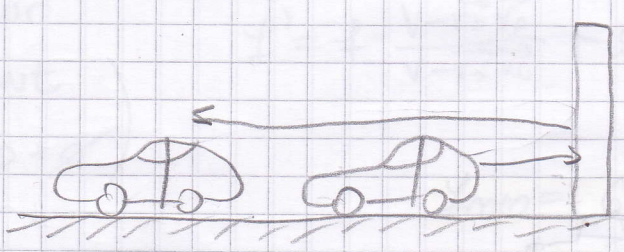
$$v_0 - v_z = \frac{v}{30}$$

$$v_i = \frac{v}{30}$$

$$v_p = \frac{v}{10} + \frac{v}{30} = \frac{4v}{3}$$

$$f' = f \cdot \frac{v - \vec{r_0}\vec{v_p}}{v - \vec{r_0}\vec{v_i}} = 1000 \frac{340 - |\vec{r_0}||\vec{v_p}|\cos 0}{340 - |\vec{r_0}||\vec{v_i}|\cos 0} = 1000 \frac{340 - \frac{4v}{3}}{340 - \frac{v}{30}} = 896\,Hz$$

b)



$$v_i = \frac{v}{30}$$

$$f' = 1000 \cdot \frac{340}{340 - |\vec{r_0}||\vec{v_i}|\cos 180°} = \frac{340}{340 - \frac{v}{30}} = 967\,Hz$$

c)

$$f'' = 967 \frac{340 - \frac{4v}{30}}{340 - 0} = 838\,Hz$$

ISPRIČAVAM SE NA NEPOTPUNOM ZADATKU
NISAM GA BAŠ ČUO!!!

JAKOST I GLASNOĆA ZVUKA

$I_0 = 10^{-12}\ W/m^2$ → prag čujnosti

– razina zvuka (jakost)

$$L = 10 \log \frac{I}{I_0} \ [dB]$$

$I = \frac{P}{S}$ ↗ snaga
↘ površina

① $L = 75\,dB$

$r = 100\,m$

$P = ?$

$P = I \cdot S$ $\qquad L = 10 \log \frac{I}{I_0} \rightarrow I = I_0 \, 10^{\frac{L}{10}}$

$P = I_0 \cdot 10^{\frac{L}{10}} \cdot 4r^2\pi = 3,97\ W$

② $L_1 = 95\,dB$

$L_2 = ?$

$L_1 = 10 \log \frac{I_1}{I_0} \rightarrow I_1 = I_0 \, 10^{\frac{L}{10}}$

$I_2 = 2I_1$

$L_2 = 10 \log \frac{I_2}{I_0} = 98,01\,dB$

(3.)

$d = 20\,cm = 0{,}2\,m$

$I = 10{,}4\ W/m$

$P = ?$

$I = \frac{P}{S} \rightarrow P = I \cdot S = 10{,}4 \cdot r^2\pi = 0{,}326\,W$

(4.) $r_1 = 20\,m \rightarrow 50I$

$r_2 = ? \rightarrow \frac{1}{50}I$

$I = 10\ W/m^2$ – ostečeje sluha (trajno)

$P = I \cdot S$

$P_1 = I_1 \cdot 4r_1^2\pi$

$P_2 = I_2 \cdot 4r_2^2\pi$

$P_1 = P_2$

$\frac{I_2}{I_1} = \left(\frac{r_1}{r_2}\right)^2$

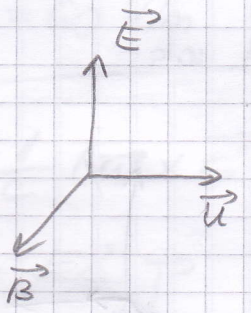
$\frac{I_2}{I_1} \cdot r_2^2 = r_1^2$

$r_2^2 = \frac{I_1 r_1^2}{I_2} = \sqrt{400 \cdot \frac{50I}{\frac{1}{50}I}} = 1000\,m$

ELEKTROMAGNETSKI VALOVI

$$\vec{E} = \left(\frac{1}{\varepsilon\mu}\right)(\vec{B}\times\vec{u}) = c\,(\vec{B}\times\vec{u})$$

$\vec{u}$ → jedinični vektor u smjeru širenja vala



$$\vec{E} = c\,(\vec{B}\times\vec{u})$$

$$\frac{1}{c}\vec{E} = \vec{B}\times\vec{u}$$

$$\frac{1}{c}(\vec{u}\times\vec{E}) = \vec{B}$$

POYNTINGOV VEKTOR

$$\vec{S} = \vec{E}\times\vec{H}$$

1.

$$\vec{E} = \vec{k}\,E_0 \cdot f(y-ct)$$

→ smjer kretanja vala

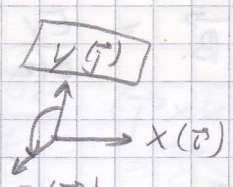
B - ?

$$\vec{B} = \frac{1}{c}(\vec{u}\times\vec{E}) = \frac{1}{c}(\vec{j}\times\vec{k}\,E_0 \cdot f(y-ct))$$

$$\vec{B} = \frac{1}{c}E_0 f(y-ct)\cdot(\vec{j}\times\vec{k})$$

$$\vec{B} = \frac{1}{c}E_0 f(y-ct)\,\vec{i}$$

$\vec{u} = \vec{j}$



pravilo desne ruke

(2.) $E_x = E_z = 0$

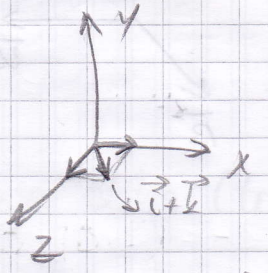
$E_y = 2{,}5 \cdot 10^{-3} \frac{V}{m} \sin[(x+z) \cdot 10^5 m^{-1} - \omega t]$

→ smjer kretanja vala

$\vec{E} = E_x \vec{i} + E_y \vec{j} + E_z \vec{k}$

$= 0 \cdot \vec{i} + E_y \vec{j} + 0 \cdot \vec{k}$

$= E_y \vec{j}$



$\vec{u} = \frac{\vec{i}+\vec{k}}{\sqrt{2}}$

$B = \frac{1}{c}(\vec{u} \times \vec{E})$

$\vec{B} = \frac{1}{c}\left(\frac{\vec{i}+\vec{k}}{\sqrt{2}} \times E_y \vec{j}\right)$

$= \frac{E_y}{c\sqrt{2}}((\vec{i}+\vec{k}) \times \vec{j}) = \frac{E_y}{c\sqrt{2}}(\vec{i} \times \vec{j} + \vec{k} \times \vec{j})$

$\vec{B} = \frac{E_y}{c\sqrt{2}}(\vec{k} - \vec{i}) = -\frac{E_y}{c\sqrt{2}}\vec{i} + \frac{E_y}{c\sqrt{2}}\vec{k}$ → uvrstiti se E_y

(4) $E_x = E_y = 0$, $\mu = 4\pi \cdot 10^{-7}$, $3 \cdot 10^8$

$E_z = 0{,}3 \frac{V}{m} \sin\left[2\pi \cdot 10^{14} s^{-1}\left(t - \frac{x}{3 \cdot 10^8 \frac{m}{s}}\right)\right]$

$\vec{S} = \vec{E} \times \vec{H} = (E_z \vec{k}) \times \left(-\frac{E_z}{\mu c}\vec{j}\right) = -\frac{E_z^2}{\mu c}(\vec{k} \times \vec{j}) = \frac{E_z^2}{\mu c}\vec{i}$

$\vec{H} = \frac{\vec{B}}{\mu} = -\frac{E_z}{\mu c}\vec{j}$

$\vec{B} = \frac{1}{c}(\vec{u} \times \vec{E}) = \frac{1}{c}(\vec{i} \times E_z \vec{k}) = \frac{E_z}{c}(\vec{i} \times \vec{k}) = -\frac{E_z}{c}\vec{j}$

uvrstimo:

$\vec{S} = \frac{0{,}3^2}{4\pi \cdot 10^{-7} \cdot 10^8} \sin^2\left(2\pi \cdot 10^{14} s^{-1}\left(t - \frac{x}{3 \cdot 10^8 \frac{m}{s}}\right)\right)\vec{i}$

5. $f = 1{,}5 \cdot 10^{14}\ Hz$

$\vec{E} = \vec{i} \cdot E_0 \sin(\omega t - kz)$

$E_0 = 60\ V/m$

$\vec{B} = \frac{1}{c}(\vec{u} \times \vec{E}) = \frac{1}{c}(\vec{k} \times E\vec{i}) = \frac{E}{c}\vec{j}$

$\vec{B} = \frac{E}{c}\vec{j}$

$\overline{S} = \frac{1}{2}\varepsilon_0 \cdot E_0^2 \cdot c = \frac{1}{2} 8{,}854 \cdot 10^{-12} \cdot 60^2 \cdot 3 \cdot 10^8 = 4{,}781\ W/m^2$

6. $\vec{B} = B_z\vec{k}$

$\vec{E} = c(\vec{B} \times \vec{u}) = c(B_z \cdot \vec{k} \times \vec{i}) = cB_z\vec{j}$

$\vec{S} = \vec{E} \times \vec{H} = cB_z\vec{j} \times \frac{\vec{B}}{\mu} = cB_z\vec{j} \times \frac{B_z\vec{k}}{\mu} = \frac{cB_z^2}{\mu}(\vec{j} \times \vec{k})$

$\vec{S} = \frac{cB_z^2}{\mu}\vec{i}$

7. $\overline{S} = 0{,}5\ W/m^2 = \frac{1}{2}\varepsilon_0 E_0^2 c$

$\lambda = 600\ nm$

$\vec{u} = \frac{1}{\sqrt{2}}(-\vec{i} + \vec{j})$

$\vec{B} \rightarrow$ xy ravnina

$\vec{E}, \vec{B} = ?$

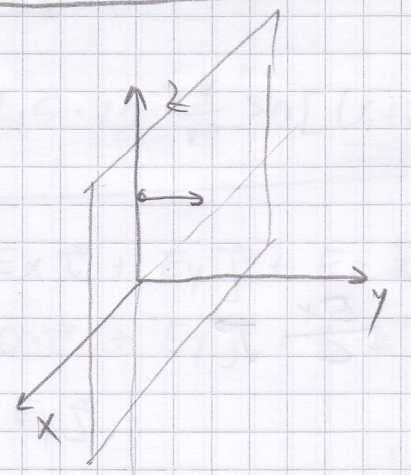
$v = \lambda \cdot f = c = \lambda \cdot \frac{\omega}{2\pi} \Rightarrow \omega = \frac{2\pi c}{\lambda} = 2\pi \frac{10^8}{600 \cdot 10^{-9}} = \pi \cdot 10^{15}$

$E_0 = 33{,}6\ V/m$

$\vec{E} = E_0\vec{k} \cdot \sin\left(\pi \cdot 10^{15} - \frac{(-x+y)}{3 \cdot 10^8}\right)$, $\vec{B} = \frac{E_0}{c\sqrt{2}}(\vec{j} + \vec{i}) = \frac{E_0}{c\sqrt{2}}\vec{i} + \frac{E_0}{c\sqrt{2}}\vec{j}$

MAXWELOVE JEDNADŽBE

1.



$$\Phi = \iint_S \vec{B}\cdot d\vec{S} = \iint_S (B_x\vec{i} + B_y\vec{j})\vec{n}\,dS$$

$$= \iint_S (B_x\vec{i} + B_y\vec{j})\vec{j}\,dS$$

$$= \iint_S B_y\,dS = B_y \iint_S dS = B_y S$$

$$B_X = B_y = 0{,}06\,T\cos(10^3 s^{-1} t)$$

$$B_z = 0$$

$$U_{ind} = -\frac{d\Phi}{dt} = -\frac{d}{dt}(B_y S) = -S\frac{dB_y}{dt}$$

$$= -S(-\sin(10^3 t)\cdot 10^3)\cdot 0{,}06$$

$$= 0{,}5\cdot 0{,}06\cdot 10^3 \sin(10^3 t)$$

$$U_{ind} = 0{,}03\sin(10^3 t)\,V$$

2.

$$\oint \vec{H}\,d\vec{e} = \sum I$$

$$\underbrace{\vec{H}\cdot\vec{n}}_{H}\,de$$

$$\oint H\,de = H\underbrace{\oint de}_{2r\pi}$$

a) $0 < r < R_1$

$$J = \frac{I}{S} = \frac{I}{R_1^2\pi}$$

$$H\cdot 2r\pi = \iint_S \vec{J}\,d\vec{S} = \iint J\,dS = \frac{I}{R_1^2\pi}\iint dS$$

I TAKO DALJE... MAXWELA MI SE NEDA PISATI, PA TKO VOLI NEKA IZVOLI.