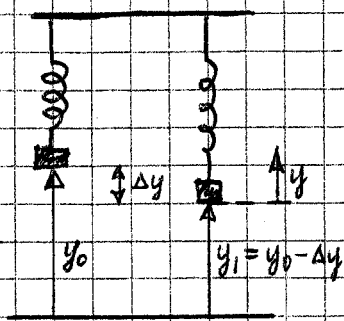


Oppgave 1

$$a) \quad mg = k \Delta y$$

$$\Delta y = \frac{mg}{k} = \frac{0,2 \cdot 9,81}{30} \text{ m} = \underline{0,065 \text{ m}}$$

b) Vi bruker likevektsposisjonen y , som utgangspunkt for y

$$ma + ky = 0$$

$$m \frac{d^2 y}{dt^2} + ky = 0$$

Prover løsning $y(t) = A \sin(\omega t + \delta)$

$$\frac{dy}{dt} = \omega A \cos(\omega t + \delta)$$

$$\frac{d^2 y}{dt^2} = -\omega^2 A \sin(\omega t + \delta)$$

$$m(-\omega^2 A \sin(\omega t + \delta)) + k A \sin(\omega t + \delta) = 0$$

$$-m\omega^2 + k = 0 \Rightarrow \omega = \sqrt{k/m} \text{ gir løsning}$$

$\Rightarrow y(t) = A \sin(\omega t + \delta)$ med $\omega = \sqrt{k/m}$ beskriver svingningene

$$c) \quad f = \omega / 2\pi = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{\frac{30}{0,2}} \text{ Hz} = \underline{1,95 \text{ Hz}}$$

$$T = 1/f = 1/1,95 \text{ s} = \underline{0,51 \text{ s}}$$

$$\omega = \sqrt{k/m} = \sqrt{30/0,2} \text{ s}^{-1} = 12,25 \text{ s}^{-1}$$

d) I øvre stilling (y_0) er hastigheten $v = 0$, og fjæren er hverken strukket eller sammenpresset

$$\Rightarrow E_{\text{tot}} = mg(y_1 + \Delta y) = 0,2 \cdot 9,81 \cdot (1 + 0,065) \text{ J} = \underline{2,09 \text{ J}}$$

$$\text{Amplituden } A = \Delta y = \underline{0,065 \text{ m}}$$

$$e) \quad t = 0 \text{ s} \quad y = 0,065 \text{ m} \quad v_0 = 0 \text{ m/s}$$

$$f) \quad a = \frac{d^2 y}{dt^2} = -\omega^2 A \sin(\omega t + \pi/2)$$

$$a_{\text{max}} = \pm \omega^2 A = \pm \frac{k}{m} A = \pm \frac{30}{0,2} \cdot 0,065 \text{ m/s}^2 = \underline{\pm 9,81 \text{ m/s}^2}$$

$$= \pm \frac{k}{m} \Delta y = \pm \frac{k}{m} \cdot \frac{mg}{k} = \pm g$$

(2)

Oppgave 2

a) Egnet Gaussflate: Sylinder med lengde l
 $0 < r < R_1$: Omstøttet ladning: $Q = \pi r^2 l \cdot \rho$

$$\int \vec{E} \cdot d\vec{A} = E \cdot 2\pi r l = \frac{Q}{\epsilon_0} = \frac{\pi r^2 l \rho}{\epsilon_0}$$

$$E = \frac{\rho r}{2\epsilon_0}$$

b) $R_1 < r < R_2$: Omstøttet ladning: $Q = \pi R_1^2 l \rho$

$$\int \vec{E} \cdot d\vec{A} = E \cdot 2\pi r l = \frac{Q}{\epsilon_0} = \frac{\pi R_1^2 l \rho}{\epsilon_0}$$

$$E = \frac{\rho R_1^2}{2\epsilon_0 r}$$

c) $R_2 < r < R_3$: Omstøttet ladning: $Q = \pi R_1^2 l \rho + \pi(r^2 - R_2^2) l \rho$
 $Q = \pi l \rho (R_1^2 + r^2 - R_2^2)$

$$\int \vec{E} \cdot d\vec{A} = E \cdot 2\pi r l = \frac{Q}{\epsilon_0}$$

$$E = \frac{\rho (R_1^2 + r^2 - R_2^2)}{2\epsilon_0 r}$$

d) $r > R_3$: Omstøttet ladning: $Q = \pi R_1^2 l \rho + \pi(R_3^2 - R_2^2) l \rho$

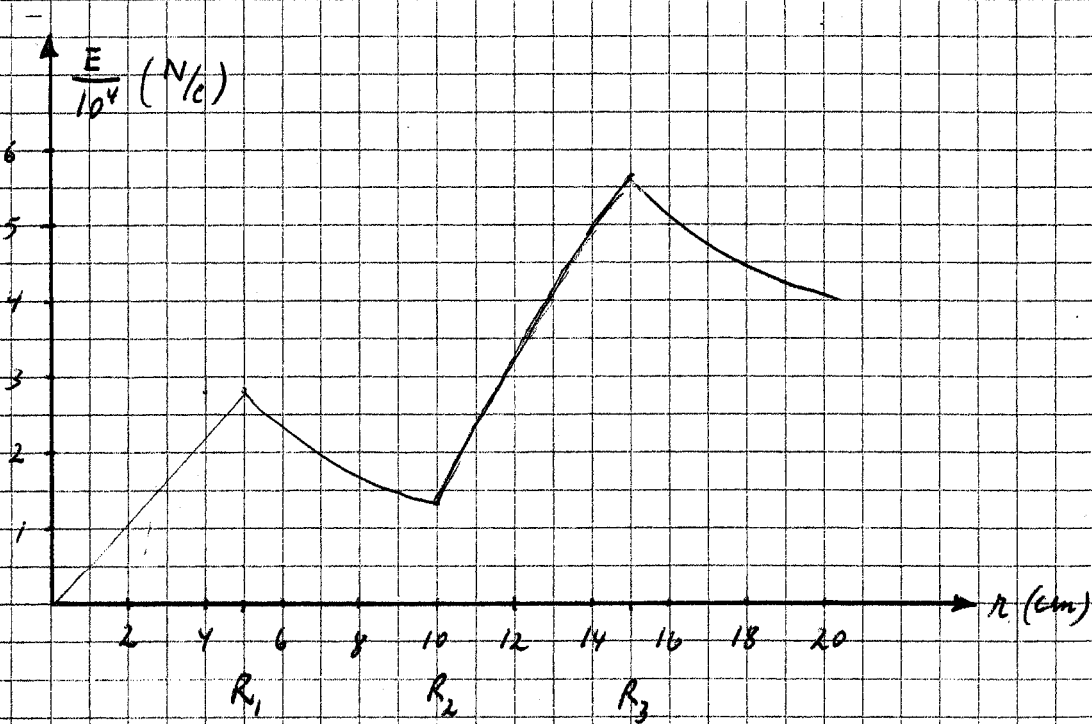
$$\int \vec{E} \cdot d\vec{A} = E \cdot 2\pi r l = \frac{Q}{\epsilon_0} = \frac{\pi l \rho (R_1^2 + R_3^2 - R_2^2)}{\epsilon_0}$$

$$E = \frac{\rho (R_1^2 + R_3^2 - R_2^2)}{2\epsilon_0 r}$$

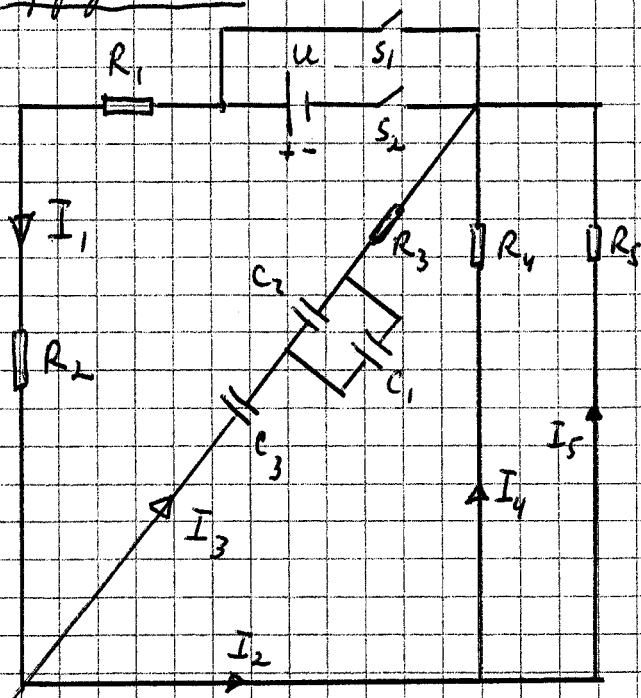
Oppgave 2 forts.

e)

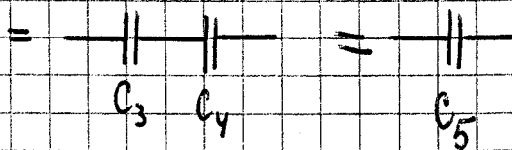
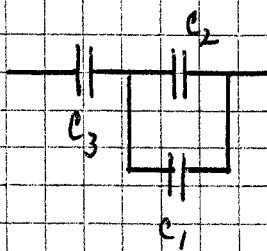
r	E
$0 < r < R_1$	$\propto r$
R_1	$\frac{\rho R_1}{2 \epsilon_0} = 2.82 \cdot 10^4 \text{ N/C}$
$R_1 < r < R_2$	$\propto 1/r$
R_2	$\frac{\rho R_1}{4 \epsilon_0} = 1.41 \cdot 10^4 \text{ N/C}$
$R_2 < r < R_3$	$\frac{\rho(r^2 - 3R_2^2)}{2 \epsilon_0 r}$
R_3	$\frac{\rho R_1}{\epsilon_0} = 5.65 \cdot 10^4 \text{ N/C}$
$> R_3$	$\propto 1/r$



Oppgave 3.



a) Vi ser på kondensator-
koblingen



$$C_4 = C_1 + C_2 = (1+2) \mu\text{F} = 3 \mu\text{F}$$

$$C_5 = \frac{C_3 \cdot C_4}{C_3 + C_4} = \frac{3 \cdot 3}{3+3} \mu\text{F} = 1.5 \mu\text{F}$$

b) Når kondensatorane er fullt oppladet, er $I_3 = 0$

Parallellkoblingen av R_4 og R_5 har ekvivalentmotstand

$$R_6 = \frac{R_4 \cdot R_5}{R_4 + R_5} = \frac{40 \cdot 50}{40 + 50} \Omega = 22.2 \Omega$$

$$I_1 = I_2 = \frac{U}{R_6 + R_1 + R_2} = \frac{12.0}{22.2 + 10 + 20} \text{ A} = 0.23 \text{ A}$$

$$I_4 = I_2 \cdot \frac{R_6}{R_4} = 0.23 \cdot \frac{22.2}{40} \text{ A} = 0.13 \text{ A}$$

$$I_5 = I_2 - I_4 = (0.23 - 0.13) \text{ A} = 0.10 \text{ A}$$

Retninger som vist i figuren.

c) Spenningen over kondensatorkoblingen er lik

$$\text{spenningen over } R_6: V_6 = I_2 \cdot R_6 = 0.23 \cdot 22.2 \text{ V} = 5.1 \text{ V}$$

$$Q_5 = C_5 V_6 = 1.5 \cdot 10^{-6} \cdot 5.2 \text{ C} = 7.7 \mu\text{C}$$

$$Q_3 = Q_4 = Q_5 = 7.7 \mu\text{C}$$

(5)

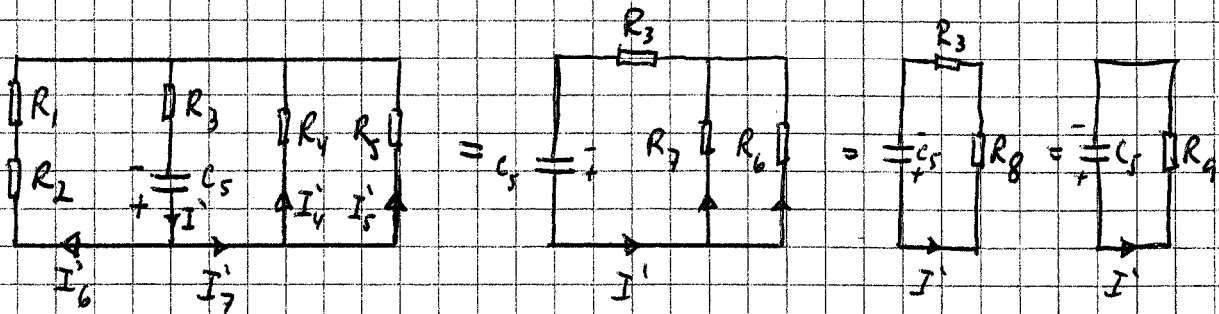
c) forts

Spänningen över C_4 är $V_4 = \frac{Q_4}{C_4} = \frac{7.3 \cdot 10^{-6}}{3 \cdot 10^{-6}} V = 2.6V$

$Q_1 = V_4 \cdot C_1 = 2.6 \cdot 1 \cdot 10^{-6} C = 2.6 \mu C$

$Q_2 = V_4 \cdot C_2 = 2.6 \cdot 2 \cdot 10^{-6} C = 5.2 \mu C$

d) Kretsen kan nå ekvivaleras med



$R_7 = R_1 + R_2 = (10 + 20) \Omega = 30 \Omega$

$R_8 = \frac{R_7 \cdot R_6}{R_7 + R_6} = \frac{30 \cdot 22.2}{30 + 22.2} \Omega = 12.8 \Omega$

$R_9 = R_3 + R_8 = (30 + 12.8) \Omega = 42.8 \Omega$

$\frac{Q_5}{C_5} - I' \cdot R_9 = 0 \quad I' = -\frac{dQ_5}{dt}$

$\frac{Q_5}{C_5} + \frac{dQ_5}{dt} R_9 = 0$

$\frac{dQ_5}{Q_5} = -\frac{dt}{R_9 C_5} \Rightarrow \ln Q_5 = -\frac{t}{R_9 C_5} + K$

$Q_5 = K \exp(-\frac{t}{R_9 C_5}) \quad t=0: Q_5 = Q_5 = K = Q_5$

$I' = -\frac{dQ_5}{dt} = \frac{Q_5}{R_9 C_5} \exp(-\frac{t}{R_9 C_5}) = \frac{7.8 \cdot 10^{-6}}{42.8 \cdot 1.5 \cdot 10^{-6}} \exp(-\frac{t \cdot 10^6}{42.8 \cdot 15})$

$I' = 0.12 \exp(-\frac{t \cdot 10^6}{64.2}) A = I_3 \quad t \text{ mätt i sek}$

(6)

$$I_6' = I_1' = I_2' = I' \cdot \frac{R_8}{R_7} = 0,12 \cdot \frac{12,8}{30} \exp\left(\frac{-t \cdot 10^6}{64,2}\right) A$$
$$= \underline{0,05 \exp\left(\frac{-t \cdot 10^6}{64,2}\right) A}$$

$$I_5' = I' \cdot \frac{R_8}{R_5} = 0,12 \cdot \frac{12,8}{50} \exp\left(\frac{-t \cdot 10^6}{64,2}\right) A = \underline{0,03 \exp\left(\frac{-t \cdot 10^6}{64,2}\right) A}$$

$$I_4' = I' \cdot \frac{R_8}{R_4} = 0,12 \cdot \frac{12,8}{40} \exp\left(\frac{-t \cdot 10^6}{64,2}\right) A = \underline{0,04 \exp\left(\frac{-t \cdot 10^6}{64,2}\right) A}$$

(7)

Oppgave 4.

a) $f = 25 \text{ cm}$ fordi billedavstand = fokallavstand ved avbildning av fjernt objekt.

$$b) \frac{1}{f} = \frac{n-1}{1} \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\frac{1}{25} = \frac{1.5-1}{1} \left(\frac{1}{R_1} - \frac{1}{(-25)} \right) \Rightarrow R_1 = \underline{25 \text{ cm}}$$

$$c) \frac{1}{n} + \frac{1}{s} = \frac{1}{f}$$

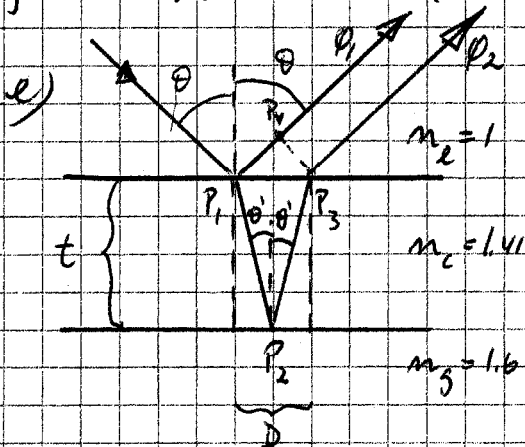
$$\frac{1}{i} = \frac{1}{f} - \frac{1}{s} = \frac{1}{25} - \frac{1}{100} \Rightarrow i = \underline{33.3 \text{ cm}}$$

$$M = -\frac{i}{s} = -\frac{33.3}{100} = \underline{-\frac{1}{3}}$$

Bildet er 33,3 cm fra linsen, og på motsatt side av linsen i forhold til objektet. Bildet er forminsket (til $\frac{1}{3}$), omvendt og reelt.

$$d) \frac{1}{i} + \frac{1}{s} = \frac{1}{f} = \frac{n_2 - n_1}{n_1} \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\frac{1}{f} = \frac{1.5 - 1.3}{1.3} \left(\frac{1}{25} - \frac{1}{(-25)} \right) \Rightarrow f = \underline{81.25 \text{ cm}}$$



$$1 \cdot \sin 45^\circ = 1.41 \cdot \sin \theta'$$

$$\Rightarrow \theta' = 30^\circ$$

$$P_1 P_4 = l \quad P_1 P_3 = d$$

$$P_1 P_2 = P_2 P_3 = d$$

$$\varphi_1 = \pi + 2\pi \cdot \frac{l}{\lambda}$$

$$\varphi_2 = \pi + 2\pi \cdot \frac{2d}{\lambda} \cdot n_2$$

$$\varphi = \varphi_2 - \varphi_1 = \frac{2d n_2 \cdot 2\pi}{\lambda} - \frac{2\pi l}{\lambda} = \frac{2\pi}{\lambda} (2d n_2 - l) = m \cdot 2\pi$$

$$m = 1, 2, 3, \dots$$

$$2 \cdot \frac{t}{\cos \theta'} \cdot n_c - 2t \cdot \tan \theta' \sin \theta = m \cdot \lambda$$

$$t = \frac{\lambda m}{2 \left(\frac{n_c}{\cos \theta'} - \frac{\sin \theta' \sin \theta}{\cos \theta} \right)} = \frac{\lambda m \cos \theta'}{2 (n_c - \sin \theta' \sin \theta)}$$

$$t = \frac{\lambda m \cos 30^\circ}{2 (1.41 - \sin 30^\circ \sin 45^\circ)} = \underline{0.41 \cdot m \cdot \lambda}$$

Gull lyp: $t = m \cdot 0.41 \cdot 585 \text{ nm}$

$$= \underline{239.9 \text{ nm}, 479.8 \text{ nm}, 719.6 \text{ nm}, \dots}$$

giri konstruktiv interferens