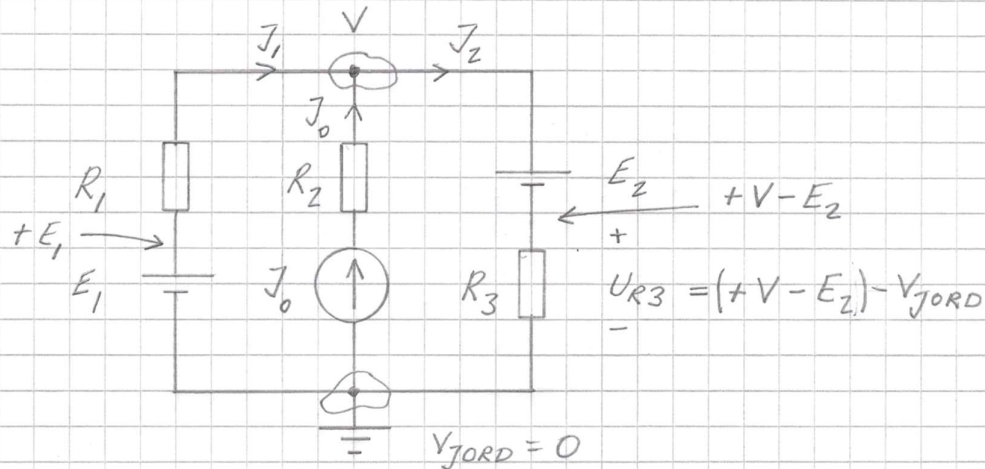


# Lösningsförslag till tentamen TMEL08 Eltekniska system 2023-08-23

1. ANVÄND EXEMPELVIS MODANALYS



$$J_1 + J_0 - J_2 = 0 \Rightarrow$$

$$\frac{E_1 - V}{R_1} + J_0 - \frac{(V - E_2) - 0}{R_3} = 0$$

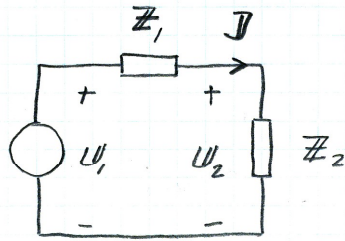
$$\frac{25 - V}{1000} + 0,005 - \frac{V - 10}{1000} = 0$$

$$25 - V + 5 - V + 10 = 0$$

$$V = +20 \text{ V}$$

$$\text{ALLTSA } U_{R3} = (+20 - 10) - 0 = \underline{\underline{10 \text{ V}}}$$

2.



$$u_1(t) = 115\sqrt{2} \sin(120\pi t - 0^\circ) \text{ V} \Rightarrow U_1 = \underbrace{120\sqrt{2}}_{\hat{U}_1} e^{j0^\circ} \text{ V}$$

$$U_2 = 230 \text{ V} \Rightarrow \hat{U}_2 = 230\sqrt{2} \text{ V}$$

$$U_2 = U_1 \cdot \frac{Z_2}{Z_1 + Z_2}$$

$$Z_1 = \frac{1}{j\omega C} = -j \frac{1}{\omega C}$$

$$Z_2 = R + j\omega L$$

$$|U_2| = |U_1| \cdot \frac{|R + j\omega L|}{| -j \frac{1}{\omega C} + R + j\omega L |}$$

$$230\sqrt{2} = 115\sqrt{2} \cdot \frac{\sqrt{20,0^2 + (120\pi \cdot 0,127)^2}}{\sqrt{20,0^2 + \left(120\pi \cdot 0,127 - \frac{1}{120\pi \cdot C}\right)^2}}$$

$$\Rightarrow \underline{\underline{C = 84,6 \mu\text{F}}}$$

$$J = \frac{U_2}{|Z_2|}$$

$$J = \frac{230}{\sqrt{20.0^2 + (120\pi \cdot 0.127)^2}} \approx 4.43 \text{ A}$$

$$P = R \cdot J^2 \Rightarrow \underline{\underline{P = 393 \text{ W}}}$$

3a)

$$\hat{U}_2 = U_c + 2 \cdot 0,70$$

$\uparrow$                      $\uparrow$   
 SPÄNNINGEN        8,0 V             $\Rightarrow \hat{U}_2 = 9,4 \text{ V}$   
 ÖVER  $N_2$

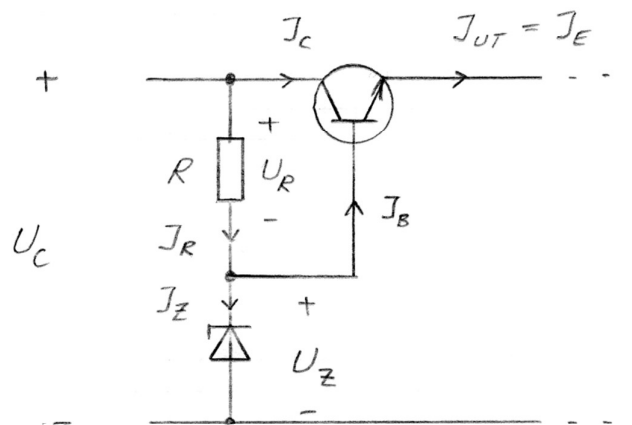
$$\frac{N_1}{N_2} = \frac{\hat{U}}{\hat{U}_2} \Rightarrow \frac{N_1}{N_2} = \frac{230\sqrt{2}}{9,4} \approx \underline{\underline{35}}$$

3b)

$$U_{UT} = U_Z - U_{BE} \Rightarrow \underline{\underline{U_{UT} = 4,9 \text{ V}}}$$

$\uparrow$                      $\uparrow$   
 5,6 V            0,70 V

3c)



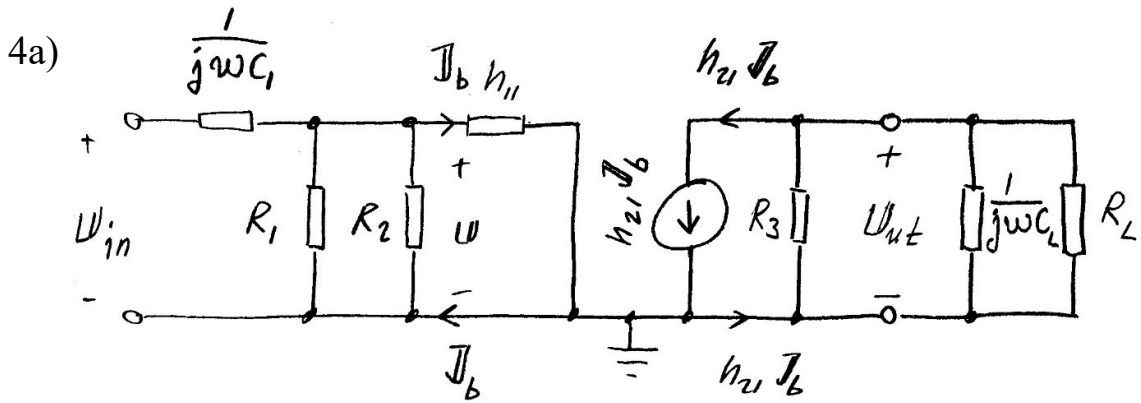
$$I_R = I_Z + I_B$$

$$I_R = \frac{U_R}{R} = \frac{U_c - U_Z}{R} \Rightarrow I_R = 20 \text{ mA}$$

$$0,020 = 0,010 + I_B \Rightarrow I_B = 10 \text{ mA}$$

$$I_{UT} = I_E = I_B + I_C = I_B + h_{FE} \cdot I_B = I_B (1 + h_{FE})$$

$$\Rightarrow \underline{\underline{I_{UT \text{ MAX}} = 0,010 (1 + 99) = 1,0 \text{ A}}}$$



$$\frac{U_{out}}{U_{in}} = \frac{U_{out}}{U} \cdot \frac{U}{U_{in}} \dots (1)$$

$$U_{out} = -h_{21} J_b \cdot \left( \frac{\frac{1}{j\omega C_2} \cdot (R_3 \parallel R_L)}{\frac{1}{j\omega C_2} + (R_3 \parallel R_L)} \right) =$$

$$= -h_{21} J_b \cdot \left( \frac{R_3 \parallel R_L}{1 + j\omega C_2 \underbrace{(R_3 \parallel R_L)}_{500 \Omega}} \right) \dots (2)$$

$$U = h_{11} J_b \dots (3)$$

$$U = U_{in} \cdot \frac{(R_1 \parallel R_2 \parallel h_{11})}{\frac{1}{j\omega C_1} + (R_1 \parallel R_2 \parallel h_{11})} =$$

$$= U_{in} \cdot \frac{j\omega C_1 (R_1 \parallel R_2 \parallel h_{11})}{1 + j\omega C_1 \underbrace{(R_1 \parallel R_2 \parallel h_{11})}_{2012 \Omega}} \dots (4)$$

$$(2) \Rightarrow U_{ut} = -150000 \mathbb{V}_b \cdot \frac{1}{1 + j \frac{\omega}{500000}}$$

$$(3) \Rightarrow U = 2500 \mathbb{V}_b$$

$$(4) \Rightarrow U = U_{in} \cdot \frac{j \frac{\omega}{124,2}}{1 + j \frac{\omega}{124,2}}$$

(2), (3) och (4) ins i (1)  $\Rightarrow$

$$\frac{U_{ut}}{U_{in}} = \frac{-150000 \mathbb{V}_b \cdot \frac{1}{1 + j \frac{\omega}{500000}} \cdot U_{in} \cdot \frac{j \frac{\omega}{124,2}}{1 + j \frac{\omega}{124,2}}}{2500 \mathbb{V}_b \cdot U_{in}}$$

$$\Rightarrow \frac{U_{ut}}{U_{in}} = -60 \cdot \frac{j \frac{\omega}{124,2}}{\left(1 + j \frac{\omega}{500000}\right) \left(1 + j \frac{\omega}{124,2}\right)}$$


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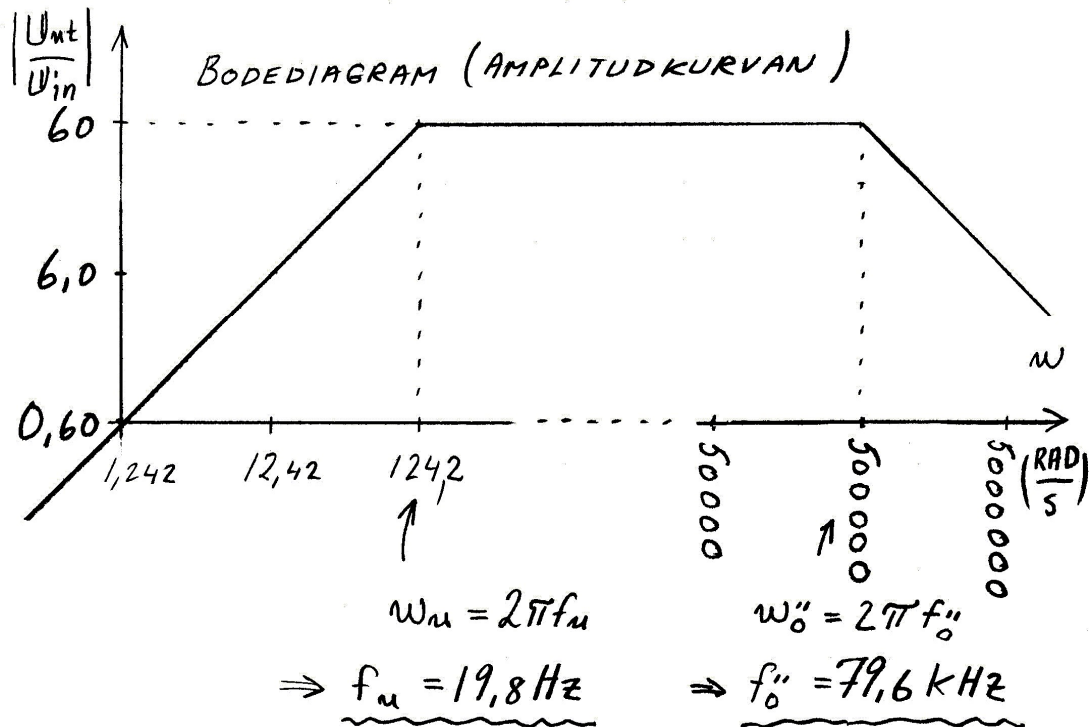
4b)

$$\left| \frac{U_{out}}{U_{in}} \right| = 0,48 \omega \cdot \frac{1}{\sqrt{1 + \left( \frac{\omega}{500000} \right)^2} \cdot \sqrt{1 + \left( \frac{\omega}{124,2} \right)^2}}$$

$$\omega \ll 124,2 \Rightarrow \left| \frac{U_{out}}{U_{in}} \right| = 0,48 \omega$$

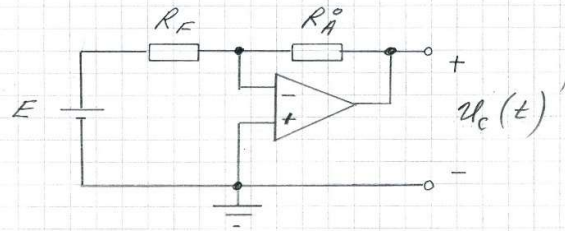
$$124,2 \ll \omega \ll 500000 \Rightarrow \left| \frac{U_{out}}{U_{in}} \right| = 60$$

$$\omega \gg 500000 \rightarrow \left| \frac{U_{out}}{U_{in}} \right| = \frac{3,0 \cdot 10^7}{\omega}$$



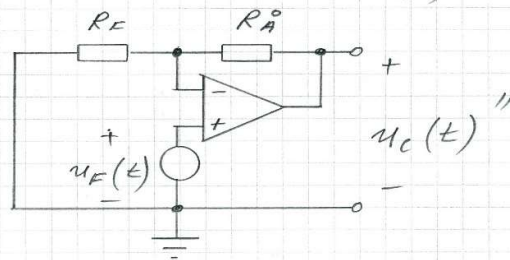
5.

NOLLSTÄLL  $u_F(t)$ . BERÄKNA  
BIDRAGET FRÅN  $E$  :



$$\frac{u_c(t)'}{E} = -\frac{R_A}{R_F} \rightarrow u_c(t)' = -4,0 \text{ V}$$

NOLLSTÄLL  $E$ . BERÄKNA  
BIDRAGET FRÅN  $u_F(t)$  :



$$\frac{u_c(t)''}{u_F(t)} = \frac{R_A + R_F}{R_F}$$

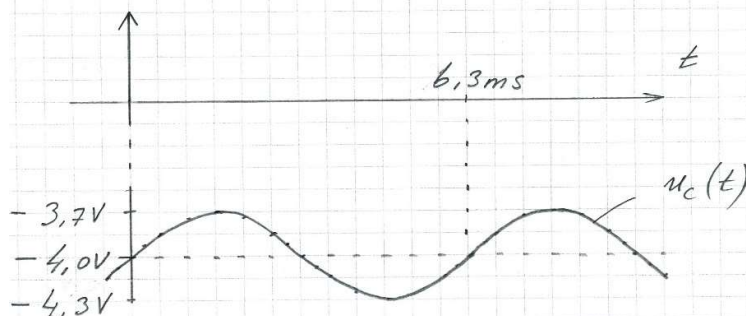
$$\Rightarrow u_c(t)'' = 0,30 \sin(1000t) \text{ V}$$

$$u_c(t) = u_c(t)' + u_c(t)'' \rightarrow$$

$$u_c(t) = -4,0 + 0,30 \sin(1000t) \text{ V}$$

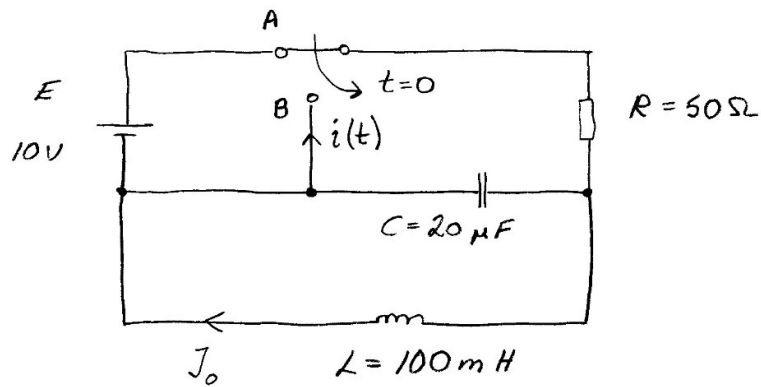
$$\omega = 1000 \frac{\text{RAD}}{\text{S}}$$

$$\omega = \frac{2\pi}{T} \Rightarrow T \approx 6,3 \text{ ms}$$





6.



BEGYNNELSEVILLKOR

DÅ BRYTAREN STÅR

I LÄGE A:

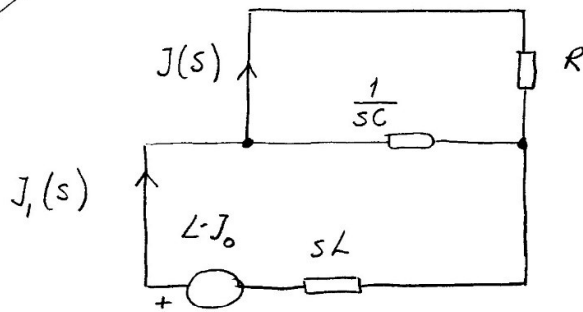
LIKSTRÖM  $\Rightarrow \omega = 0 \Rightarrow$

$$\left. \begin{aligned}
 \omega L = 0 &\Rightarrow u_L = 0 \\
 u_C &= u_L
 \end{aligned} \right\} \Rightarrow u_C = 0$$

↓  
 INGEN  
 BEGYNNELSE -  
 ENERGI I  
 KONDENSATORN.

$$J_0 = \frac{E}{R} \Rightarrow J_0 = 0,20 \text{ A}$$

OPERATORSKEMA



$$J(s) = J_1(s) \cdot \frac{\frac{1}{sC}}{R + \frac{1}{sC}} \quad (\text{STRÖMDELNING})$$

$$\text{DÄR } J_1(s) = \frac{L \cdot J_0}{sL + \frac{R \cdot \frac{1}{sC}}{R + \frac{1}{sC}}} \quad (\text{OHMS LAG})$$

$$\text{NUMERISKT } \Rightarrow J(s) = \dots =$$

$$= \frac{200}{500} \cdot \frac{500}{(s+500)^2 + 500^2}$$

LAPLACEPARLÖREN  $\Rightarrow$

$$i(t) = 0,4 \cdot e^{-500t} \cdot \sin 500t \quad A$$