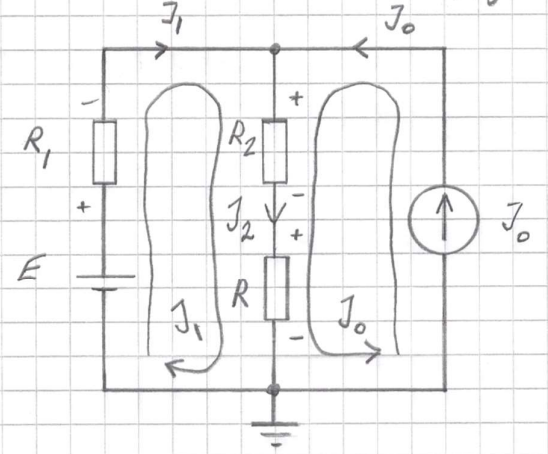
Lösningsförslag till tentamen TMEL08 Eltekniska system 2025-01-07

1. ERSÄTT DE PARALLELLKOPPLADE RESISTORERNA R_3, R_4 OCH R_5 MED EN RESISTOR

$$R = \left(\frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}\right)^{-1} = 2{,}0\ \text{k}\Omega$$



$$J_2 = J_1 + J_0 \quad \ldots (1)$$

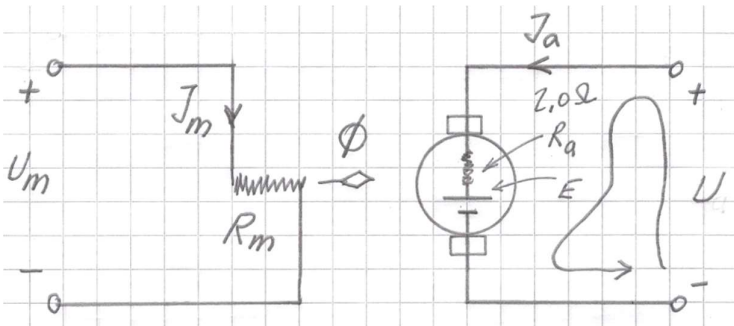
$$+E - R_1 J_1 - R_2 (J_1 + J_0) - R(J_1 + J_0) = 0$$

$$+12 - 1000\,J_1 - 1000(J_1 + 0{,}012) - 2000(J_1 + 0{,}012) = 0$$

$$\Rightarrow J_1 = -6{,}0\ \text{mA}$$

$$(1) \Rightarrow J_2 = -6{,}0 + 12\ \text{mA} = \underline{\underline{6{,}0\ \text{mA}}}$$

2. Separatmagnetiserad likströmsmotor



FALL I

$U_I = 200\ V$

$J_{aI} = 10\ A$

$E_I = ?$

$n_I = 1000\ RPM$

FALL II

$U_{II} = 170\ V$

$J_{aII} = ?$

$E_{II} = ?$

$n_{II} = ?$

SAMMA MOMENT OCH MAGNETISKT FLÖDE I DE TVÅ FALLEN.

a) $M = k_2 \Phi J_{aI}$
$M = k_2 \Phi J_{aII}$
$\Rightarrow J_{aII} = J_{aI} = \underline{10\ A}$

b) KIRCHHOFFS SPÄNNINGSLAG $\rightarrow$

$+U_I - R_a J_{aI} - E_I = 0 \rightarrow E_I = \underline{180\ V}$

$+U_{II} - R_a J_{aII} - E_{II} = 0 \rightarrow E_{II} = \underline{150\ V}$

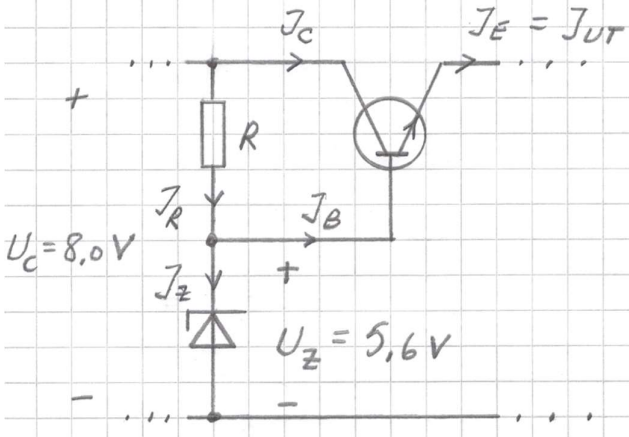
c) $\frac{E_I}{E_{II}} = \frac{k_1 \Phi n_I}{k_1 \Phi n_{II}} \Rightarrow n_{II} = \underline{833\ RPM}$

3a) $U_{UT} = U_Z - U_{BE}$

OM "ÖVERBELASTNING EJ SKER, HÅLLER SIG U_Z KONSTANT $\Rightarrow$

$U_{UT} = 5,6 - 0,70 = \underline{\underline{4,9\ V}}$

3b)



$J_R = J_Z + J_B \quad \ldots (1)$

$J_R = \dfrac{U_C - U_Z}{R} \Rightarrow J_R = 20\ mA$

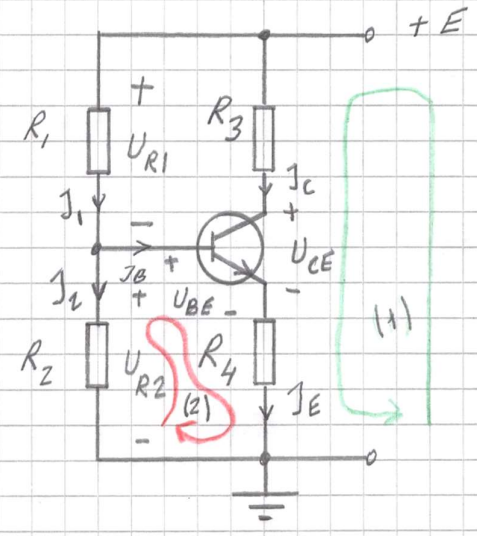
$U_Z = 5,6\ V$ om $J_{Z\,min} = 10\ mA$

$(1) \Rightarrow J_{B\,max} = 10\ mA$

$J_{UT} = J_E = J_B + J_C = J_B + h_{FE} J_B$

$\Rightarrow J_{UT\,max} = \underline{\underline{1,0\ A}}$

3c) LIKSTRÖMSSCHEMA



$+E - R_3 I_C - U_{CE} - R_4 I_E = 0 \quad \ldots (1)$

$+U_{R2} - U_{BE} - R_4 I_E = 0 \quad \ldots (2)$

$I_E = I_B + I_C = \frac{I_C}{h_{FE}} + I_C \Rightarrow I_E = 4{,}04\,mA$

$(1) \rightarrow \underline{R_4 \approx 2{,}0\,k\Omega} \quad (1980\,\Omega)$

$(2) \rightarrow U_{R2} = 8{,}1\,V$

$U_{R2} + U_{R1} = E \Rightarrow U_{R1} = 11{,}3\,V$

$I_1 = I_2 + I_B = \frac{U_{R2}}{R_2} + \frac{I_C}{h_{FE}} \rightarrow I_1 = 910\,\mu A$

$R_1 = \frac{U_{R1}}{I_1} \rightarrow \underline{R_1 \approx 12\,k\Omega} \quad (12419\,\Omega)$

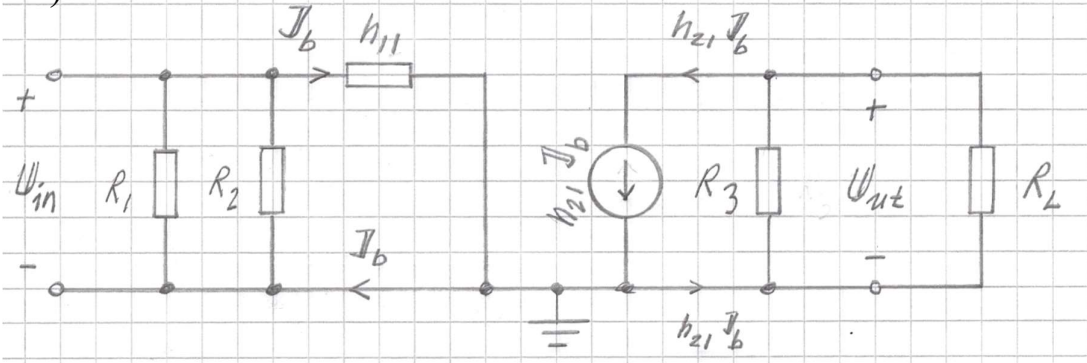
4a)

$$\frac{N_1}{N_2} = \frac{\hat{U}}{\hat{U}_2} = \frac{\hat{U}}{U_c + 2 \cdot 0{,}70} \approx \underline{\underline{35}} \; (34{,}6)$$

$\hat{U} \leftarrow 230\sqrt{2}\ \text{V}$

$U_c \uparrow 8{,}0\ \text{V}$

4b)



$$F = \frac{U_{ut}}{U_{in}} \quad \ldots (1)$$

$$U_{ut} = - h_{21} I_b \cdot \frac{R_3 \cdot R_L}{R_3 + R_L} \quad \ldots (2)$$

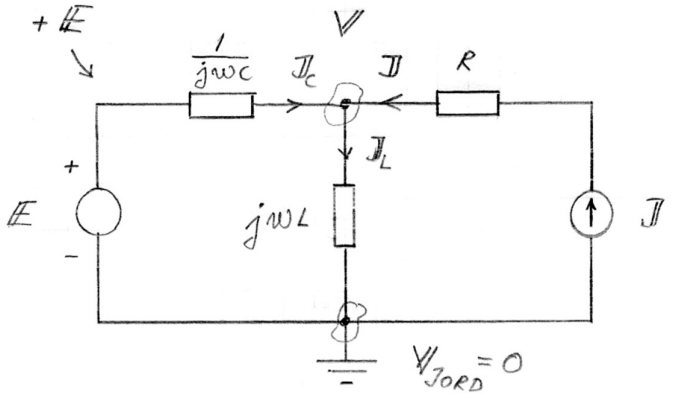
$$U_{in} = h_{11} I_b \quad \ldots (3)$$

(2) & (3) INS (1) $\rightarrow$

$$F = - \frac{h_{21} \cdot \frac{R_3 \cdot R_L}{R_3 + R_L}}{h_{11}}$$

$\rightarrow |F| = 267$ GGR

5.



$$\mathbb{I}_C + \mathbb{J} = \mathbb{I}_L \Rightarrow \mathbb{I}_C + \mathbb{J} - \mathbb{I}_L = 0$$

$$\Rightarrow \frac{+\mathbb{E} - \mathbb{V}}{1/j\omega C} + \mathbb{J} - \frac{\mathbb{V} - \mathbb{V}_{JORD}}{j\omega L} = 0$$

$$\frac{10\sqrt{2}\cdot e^{j0^\circ} - \mathbb{V}}{1/j0{,}020} + 0{,}20\sqrt{2}\cdot e^{j90^\circ} - \frac{\mathbb{V} - 0}{j\,100} = 0$$

$$j0{,}20\sqrt{2} - j0{,}02\mathbb{V} + j0{,}20\sqrt{2} + j0{,}01\,\mathbb{V} = 0$$

$$j\,0{,}01\,\mathbb{V} = j0{,}40\sqrt{2} \Rightarrow \mathbb{V} = +40\sqrt{2}\ \text{V}$$

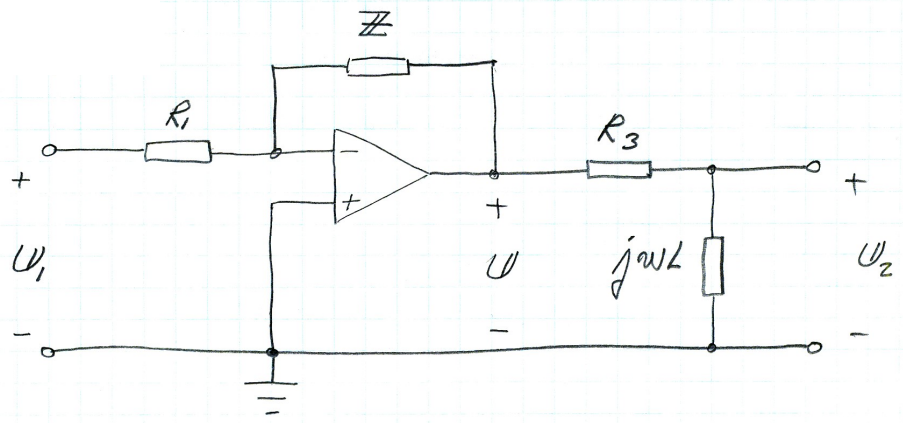
$$\mathbb{I}_L = \frac{\mathbb{V} - \mathbb{V}_{JORD}}{j\omega L} \rightarrow \mathbb{I}_L = \frac{40\sqrt{2} - 0}{j\,100} = 0{,}40\sqrt{2}\,e^{-90^\circ}\ \text{A}$$

$$\rightsquigarrow \underline{\underline{i_L(t) = 0{,}40\sqrt{2}\sin(1000t - 90^\circ)\ \text{A}}}$$

$P = R \cdot J^2$ DÄR J ÄR EFFEKTIV-VÄRDET AV $i(t)$.

$$\underline{\underline{P = 100 \cdot 0{,}20^2 = 4{,}0\ \text{W}}}$$

6a)



$$\frac{U_2}{U_1} = \frac{U_2}{U} \cdot \frac{U}{U_1} \quad \ldots (1)$$

$$U_2 = U \cdot \frac{j\omega L}{R_3 + j\omega L} \Rightarrow \frac{U_2}{U} = \frac{j\omega \cdot \frac{L}{R_3}}{1 + j\omega \cdot \frac{L}{R_3}}$$

$$\Rightarrow \frac{U_2}{U} = \frac{j\frac{\omega}{1587}}{1 + j\frac{\omega}{1587}}$$

$$\frac{U}{U_1} = -\frac{Z}{R_1} \quad \text{där} \quad Z = \frac{\frac{1}{j\omega C} \cdot R_2}{\frac{1}{j\omega C} + R_2} =$$

$$= \frac{R_2}{1 + j\omega C R_2} \Rightarrow \frac{U}{U_1} = -\frac{R_2}{R_1} \cdot \frac{1}{1 + j\omega C R_2}$$

$$\Rightarrow \frac{U}{U_1} = -10 \cdot \frac{1}{1 + j\frac{\omega}{62500}}$$

$$(1) \Rightarrow \frac{U_2}{U_1} = -10 \cdot \frac{1}{1 + j\frac{\omega}{62500}} \cdot \frac{j\frac{\omega}{1587}}{1 + j\frac{\omega}{1587}}$$

6b)

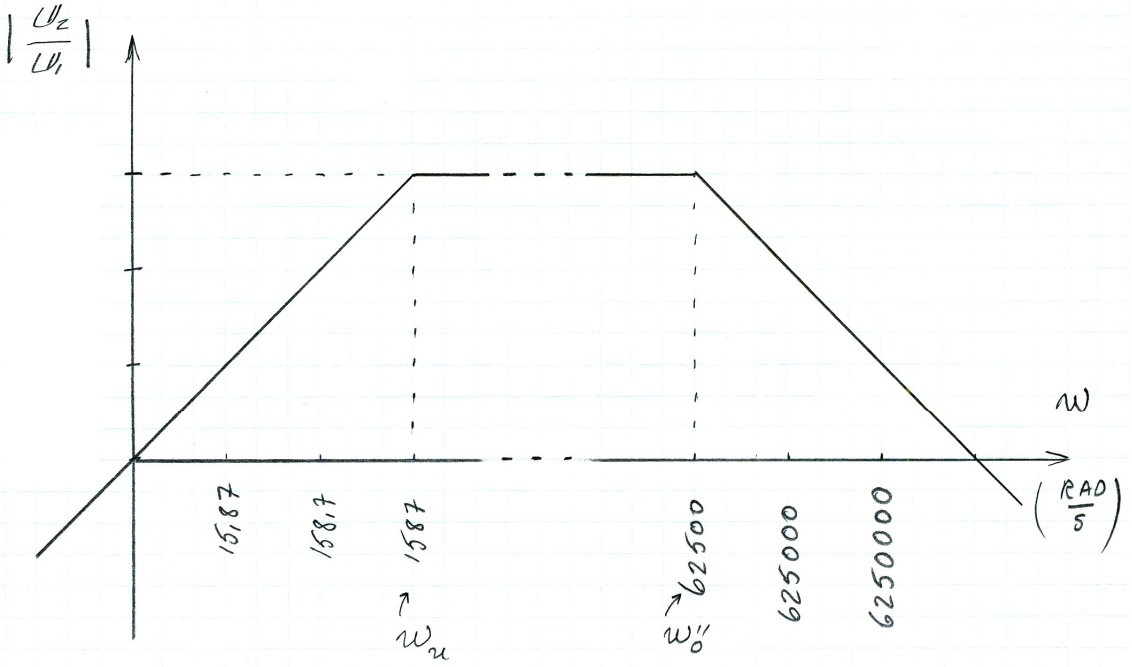
$$\left|\frac{U_2}{U_1}\right| = 10 \cdot \frac{1}{\sqrt{1^2 + \left(\frac{\omega}{62500}\right)^2}} \cdot \frac{\frac{\omega}{1587}}{\sqrt{1^2 + \left(\frac{\omega}{1587}\right)^2}}$$

OM $\omega << 1587 \frac{RAD}{S} \Rightarrow \left|\frac{U_2}{U_1}\right| \approx \frac{10}{1587} \cdot \omega$

OM $1587 \frac{RAD}{S} << \omega << 62500 \frac{RAD}{S} \Rightarrow \left|\frac{U_2}{U_1}\right| = 10$

OM $\omega >> 62500 \frac{RAD}{S} \Rightarrow \left|\frac{U_2}{U_1}\right| = \frac{625000}{\omega}$

BODEDIAGRAM (AMPLITUDKURVA)



$\omega_u = 2\pi f_u \Rightarrow \underline{f_u \approx 0{,}25\ kHz}$

$\omega_o'' = 2\pi f_o'' \Rightarrow \underline{f_o'' \approx 9{,}9\ kHz}$