7.11.10 ⑥ Vorrechnung

- a) $\underline{Z}_{ie} = ?$ $X_1 = \omega L_1 = 2\pi f \cdot L_1 = 2\pi \cdot 275\,Hz \cdot 100\,mH = (172{,}8\,\Omega \approx) \underline{173\,\Omega}$

$X_2 = \omega L_2 = 2\pi f L_2 = 431{,}9\,\Omega \approx \underline{432\,\Omega}$

$\Rightarrow \underline{Z}_1 = 10\,\Omega + j\,173\,\Omega$ $\Rightarrow \underline{Z}_2 = 25\,\Omega + j\,432\,\Omega$

$\underline{Z}_{ie} = \left(\left\{\left[\left(R_{1\,gen} \oplus R_1\right) \| R_2\right] \oplus \underline{Z}_1\right\} \| R_3\right) \oplus \underline{Z}_2 = \left(\underline{Z}'_1 \| R_3\right) \oplus \underline{Z}_2 \approx \underline{155\,\Omega + j\,580\,\Omega}$

$R_{1\,gen} \oplus R_1 = 50\,\Omega + 330\,\Omega = 380\,\Omega$

$380\,\Omega \| 220\,\Omega = 139\tfrac{1}{3}\,\Omega$

$\approx 129{,}3\,\Omega + 147{,}5\,\Omega \approx (130 + j\,148)\,\Omega$

$\approx 155\,\Omega + j\,580\,\Omega$

$\left(139\tfrac{1}{3}\,\Omega\right) + \left(10\,\Omega + j\,173\,\Omega\right) = 149\tfrac{1}{3}\,\Omega + 173\,\Omega = \underline{Z}'_1$

$\Rightarrow R_{ie} = \underline{155\,\Omega}$

$\Rightarrow X_{ie} = \underline{580\,\Omega}$

$\left.\begin{array}{l}\\\\\end{array}\right\} |\underline{Z}_{ie}| = \sqrt{R_{ie}^2 + X_{ie}^2} = \sqrt{(155\,\Omega)^2 + (580\,\Omega)^2} \approx \underline{600\,\Omega}$

- b) $R_a = |\underline{Z}_{ie}| = \underline{600\,\Omega}$

$P_a = \dfrac{U_{ae}^2}{2(R_i + R_a)} = \dfrac{(2V)^2}{2(155\,\Omega + 600\,\Omega)} = \underline{2{,}65\,mW}$

c) $P_{a\,max} = \dfrac{U_q^2}{4R_i} = \dfrac{4V^2}{4 \cdot (155\,\Omega)} = \underline{6{,}45\,mW}$

d) $R_{ie} = \left(\left(\dfrac{U_L}{U_a}\right)^2 R_a^2 - R_a^2 - \left(\dfrac{U_L}{1k}\right)^2\right) \cdot \dfrac{1}{2 \cdot R_a}$

①

U_L / mV	622
I_K / mA	1,06

$R_a = 500\,\Omega \Rightarrow U_a = \underline{356\,mV}$

$R_{ie} = \left[\left(\dfrac{U_L}{U_a}\right)^2 R_a^2 - R_a^2 - \left(\dfrac{U_L}{1k}\right)^2\right] \cdot \dfrac{1}{2R_a} = \left[\left(\dfrac{622\,mV}{356\,mV}\right)^2 \cdot 500\,\Omega^2 - 500\,\Omega^2 - \left(\dfrac{622\,mV}{1{,}06\,mA}\right)^2\right] \cdot \dfrac{1}{2 \cdot 500\,\Omega}$

$R_{ie} = \underline{187\,\Omega}$ ✓

$Z_{ie} = \dfrac{U_L}{I_K} = \dfrac{622\,mV}{1{,}06\,mA} = \underline{586\,\Omega}$ ✓

$\left.\begin{array}{l}\\\\\end{array}\right\} \Rightarrow X_{ie} = \sqrt{Z_{ie}^2 - R_{ie}^2} = \sqrt{(586\,\Omega)^2 - (187\,\Omega)^2} = \underline{555\,\Omega}$

$X_{ie} = \underline{555\,\Omega}$ ✓

Gemessene Werte weichen aufgrund der Bauteiltoleranzen und Messungenauigkeit ab!

②

R_a/Ω	100	200	300	400	450	500	550	600	700	800	900
U/mV	89	187	254	312	337	358	377	395	424	447	467
$P/\mu W$	79	174	215	243	252	256	258	260	257	249	242

Betriebsanpassung ✓

R_a/Ω	1000
U/V	483
$P/\mu W$	233

$$P = \frac{U^2}{R_a} = \frac{(89\,mV)^2}{100} = 79\,\mu W$$

$$P_{max}\,(R_a = 600\,\Omega) = 260\,\mu W$$

③

R_a/Ω	100	200	300	400	450	500	550	600	700	800	900
U/mV	122	227	305	360	383	402	420	434	459	479	495
$P/\mu W$	148	257	310	324	326	323	321	314	301	287	272

R_a/Ω	1000
U/mV	508
$P/\mu W$	258

$$P_{max}\,(R_a = 450\,\Omega) = 326\,\mu W$$

④

R_a/Ω	100	200	300	400	450	500	550	600	700	800	900
U/mV	240	334	397	438	453	466	478	488	504	517	527
$P/\mu W$	576	578	525	479	456	434	415	396	362	334	308

↑ Leistungsanpassung ✓

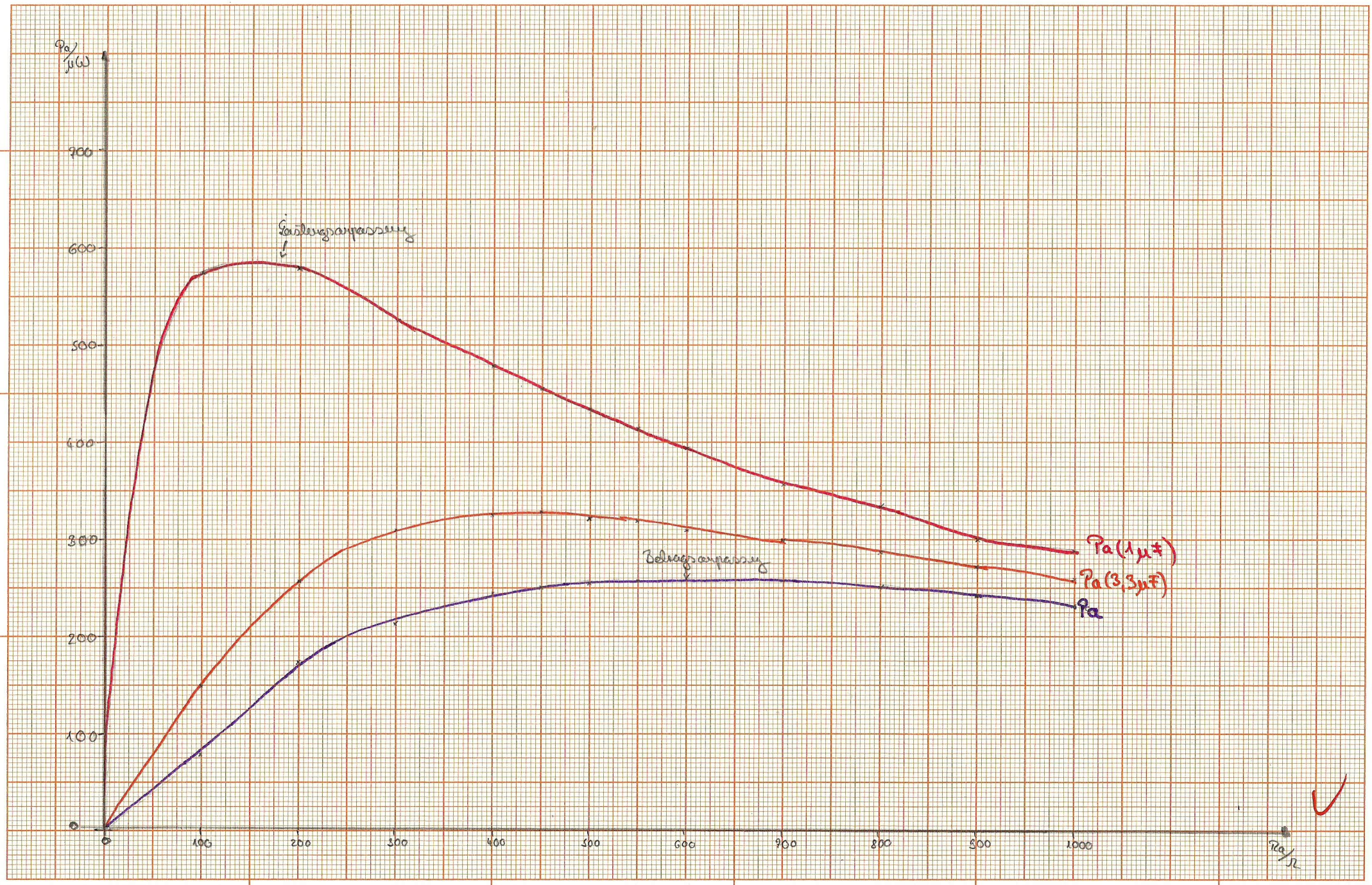
R_a/Ω	1000
U/mV	536
$P/\mu W$	287

$P_{max}\ (R_a = 200\Omega) = \underline{578\,\mu W}$

$R_{a\,opt} = 187\Omega$

$R_{a\,opt}$	187Ω
U_1	$328\ mV$
S_a	$3{,}12\ mA$
$P_{a\,opt}$	$\underline{575\,\mu W}$

$P_{a\,opt} = U_1 \cdot S_a$


Pa/µW
700
600
500
400
300
200
100
0
100
200
300
400
500
600
700
800
900
1000
Ra/Ω
Pa(1µF)
Pa(3,3µF)
Pa