Fakultet elektrotehnike i računarstva
Zavod za visoki napon i energetiku

Elektrane

Rješenja 3. domaće zadaće

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Zadani podaci:

R. br.: ***20***

Hidroelektrana: ***Dubrovnik***

Blok: ***1***

Nazivna prividna snaga: $S_n = \mathbf{120}\ \boldsymbol{MVA}$

Nazivni napon: $U_n = \mathbf{14,4}\ \boldsymbol{kV}$

Nazivna struja: $I_n = \mathbf{4810}\ \boldsymbol{A}$

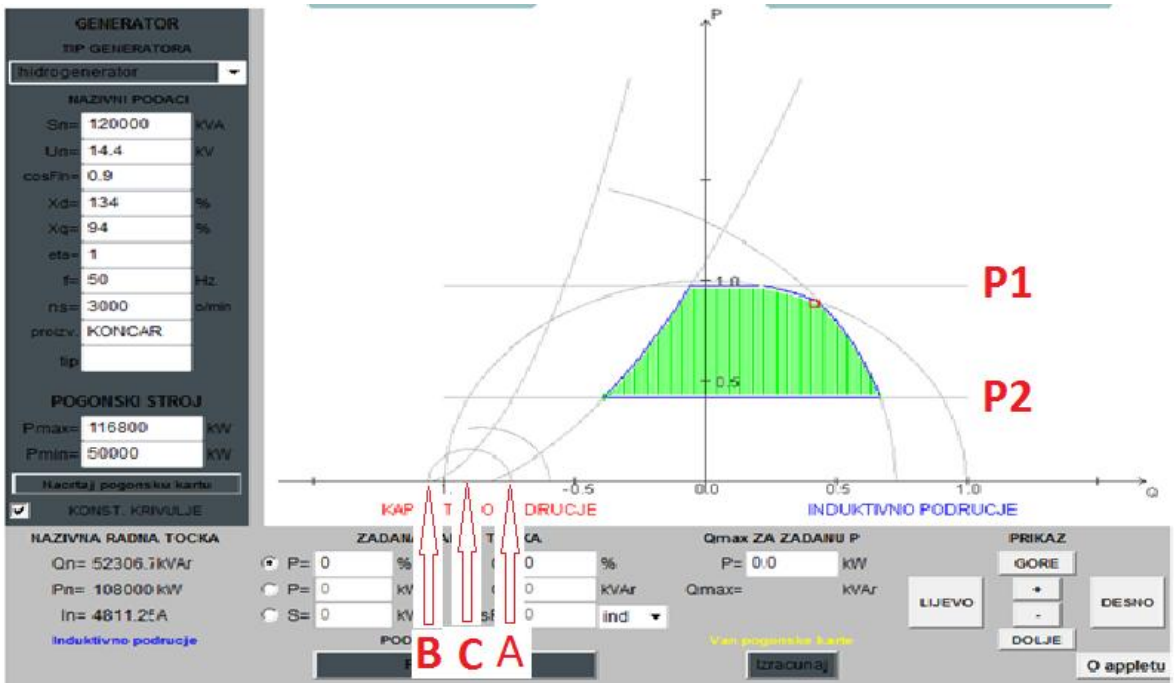
Nazivni faktor snage: $cos\varphi_n = \mathbf{0,9}$

Sinkrona reaktancija u uzdužnoj d-osi: $x_d = \mathbf{1,34}\ \boldsymbol{pu}$

Sinkrona reaktancija u poprečnoj q-osi: $x_q = \mathbf{0,94}\ \boldsymbol{pu}$

Maximalna djelatna snaga: $P_{max} = \mathbf{116,8}\ \boldsymbol{MW}$

Minimalna djelatna snaga: $P_{min} = \mathbf{50}\ \boldsymbol{MW}$



Nazivna radna točka:

$$I_n = \frac{S_n}{\sqrt{3} \cdot U_n} = 4811{,}252243\ A$$

$$P_n = cos\varphi_n \cdot S_n = 108\ MW$$

$$Q_n = sin\varphi_n \cdot S_n = 52{,}306787\ MVA$$

Pretvaranje da dobijemo per unit...

$U_B \longrightarrow U_n = 1 \qquad v_n = 1\ p.u.$

$I_B \longrightarrow I_n = 1 \qquad i_n = 1\ p.u.$

$sin\varphi_n = \sqrt{1 - cos^2\varphi_n} = 0{,}43588$

$e = \sqrt{U_n^2 + (I_n \cdot x_d)^2 + 2 \cdot U_n \cdot I_n \cdot sin\varphi_n} = \sqrt{1^2 + (1 \cdot 1{,}34)^2 + 2 \cdot 1 \cdot 1 \cdot 0{,}43588}$

$e = 1{,}915035248\ p.u.$

Točka A: $\frac{v_n^2}{x_d} = \frac{1}{1{,}34} = 0{,}746268\ p.u.$

Točka B: $\frac{v_n^2}{x_q} = \frac{1}{0{,}94} = 1{,}063829\ p.u.$

Točka C: $\frac{v_n^2}{2 \cdot x_d} + \frac{v_n^2}{2 \cdot x_q} = \frac{1}{2 \cdot 1{,}34} + \frac{1}{2 \cdot 0{,}94} = 0{,}905049\ p.u.$

Točka P1: $P_{max} = \frac{\eta \cdot P_{max}}{S_n} = \frac{1 \cdot 116.8}{120} = 0{,}9733334\ p.u$

Točka P2: $P_{min} = \frac{\eta \cdot P_{min}}{S_n} = \frac{1 \cdot 50}{120} = 0{,}4166667\ p.u$

Polumjer: $r = \frac{e \cdot v_n}{x_d} = \frac{1{,}915035248 \cdot 1}{1{,}34} = 1{,}429130782\ p.u$

Minimalna uzbuda: $0{,}1 \cdot \frac{e \cdot v_n}{x_d} = 0{,}1 \cdot \frac{1{,}915035248 \cdot 1}{1{,}34} = 0{,}1429130782\ p.u$

$\varphi_n = arcsin(0{,}43588) = 25{,}84193276°$

$q_n = \sqrt{s_n^2 - p_n^2} = \sqrt{1 - 0.9^2} = 0{,}43588$

Ograničenje zbog statičke nestabilnosti:

$p = p_{min}$

$$e = \frac{p_{min} + 0{,}1 \cdot S_n}{v_n} \cdot x_d = \frac{0{,}4166667 + 0{,}1 \cdot 1}{1} \cdot 1{,}34 = 0{,}69233378\ p.u$$

$$r = \frac{e \cdot v_n}{x_d} = \frac{0{,}69233378\ \cdot 1}{1{,}34} = 0{,}516667\ p.u.$$

$p = p_{max}$

$$e = \frac{p_{max} + 0{,}1 \cdot S_n}{v_n} \cdot x_d = \frac{0{,}9733334\ + 0{,}1 \cdot 1}{1} \cdot 1{,}34 = 1{,}438267\ p.u$$

$$r = \frac{e \cdot v_n}{x_d} = \frac{1{,}438267\ \cdot 1}{1{,}34} = 1{,}073334\ p.u.$$

$$p^2 + (q + \frac{v_n^2}{x_d})^2 = (\frac{e \cdot v_n}{x_d})^2$$

$$q = \sqrt{(\frac{e \cdot v_n}{x_d})^2 - p^2} - \frac{v_n^2}{x_d}$$

Za $p = p_{min} \longrightarrow \quad q = -0{,}440763\ p.u. \longrightarrow \quad Q = -79{,}341596\ MVA_r$

Za $p = p_{max} \longrightarrow \quad q = -0{,}293881\ p.u. \longrightarrow \quad Q = -31{,}739192\ MVA_r$