Respostas dos Exercícios do Livro

Principles of Electric Machines and Power Electronics

P. C. Sen

6.1

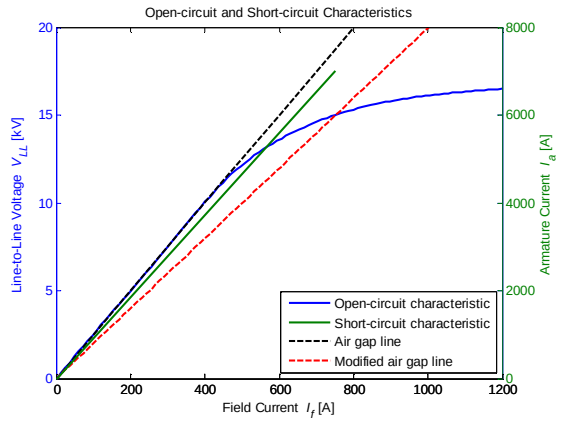
550,72 kVA, 0,44 (capacitivo)

6.2

(a) p_1 = 6 pólos e p_2 = 2 pólos
(b) p_1 = 50 pólos e p_2 = 6 pólos

6.3

(a)



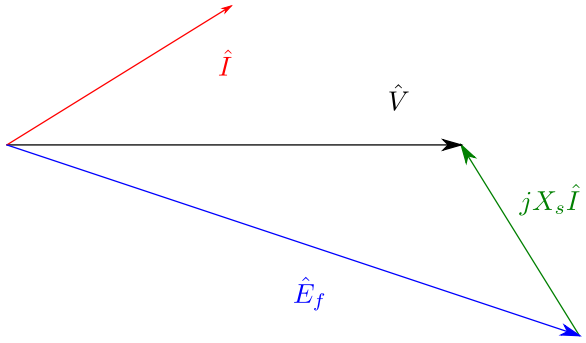
(b) $X_{s\ (unsat)}$ = 1,55 Ω (1,34 pu), $X_{s\ (sat)}$ = 1,24 Ω (1,07 pu)
(c) 602 A
(d) -9,2%

6.4

(a) 2 pólos
(b) $X_{s\ (unsat)}$ = 1,73 Ω (2,08 pu), $X_{s\ (sat)}$ = 1,44 Ω (1,73 pu)
(c)
(d) 3521 A

6.5

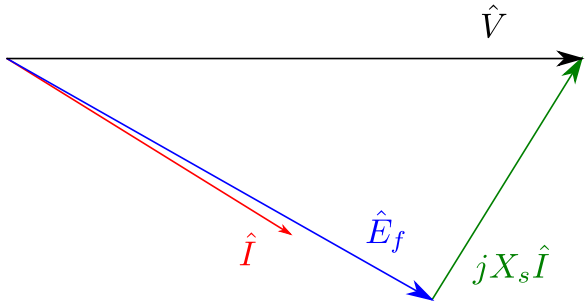
(a) $\hat{\imath}_a$ = 0,5882<31,79° pu,
$\hat{e}_f$ = 1,3284<-18,43° pu, I_f = 265,69 A



(b) V_t = 15,54 kV

6.6

(a) $\hat{\imath}_a$ = 0,5882<-31,79° pu,
$\hat{e}_f$ = 0,8506<-29,59° pu, I_f = 170,13 A



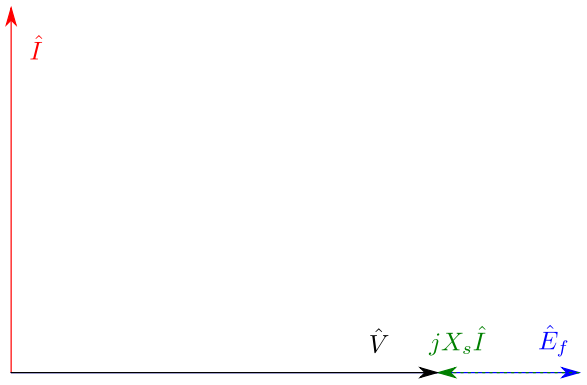
(b) V_t = 12,91 kV

6.7

1,25 pu

6.8

(a) $\hat{E}_f$ = 1768,9<-15° V
(b) $\hat{I}_a$ = 54,13<39,74° A
(c) 0,77 (capacitivo)
(d.i) $\hat{I}_a$ = 40,09<90,0° A, nulo (capacitivo)
(d.ii)



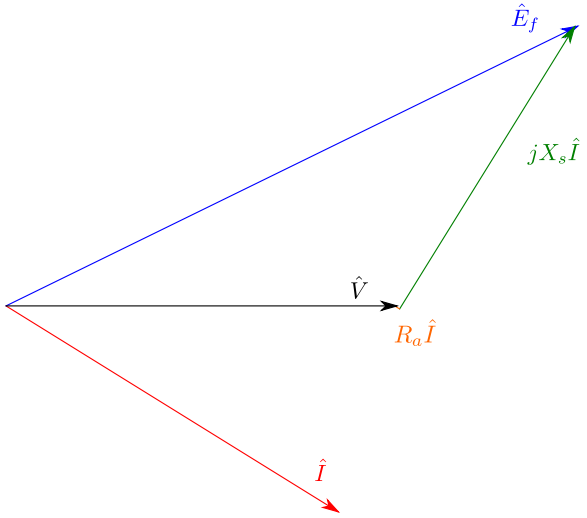
(d.iii) 25%

6.9

(a.i) $\hat{E}_f$ = 6,35<0° kV/fase
(a.ii) $\hat{I}_{curto\text{-}circuito}$ = 421,29<-84,29° A
(b.i) $\hat{E}_f$ = 7,51<8,92° kV/fase
(b.ii) 18,29%
(b.iii) 9,54 MW

6.10

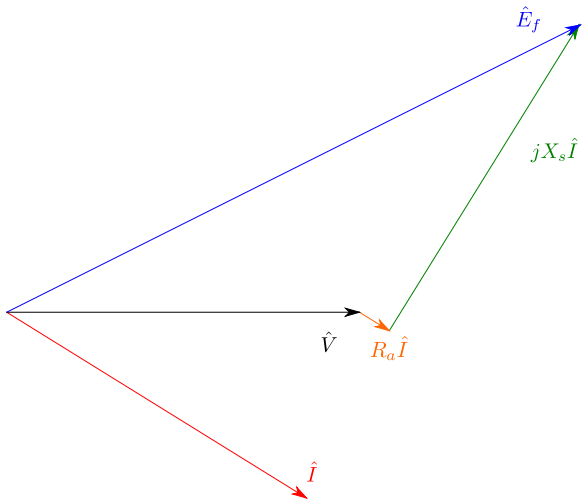
(a) 3600 rpm
(b) R_a = 0,018 Ω e X_s = 1,02 Ω
(c) $\hat{E}_f$ = 19,51<26,07° kV/fase



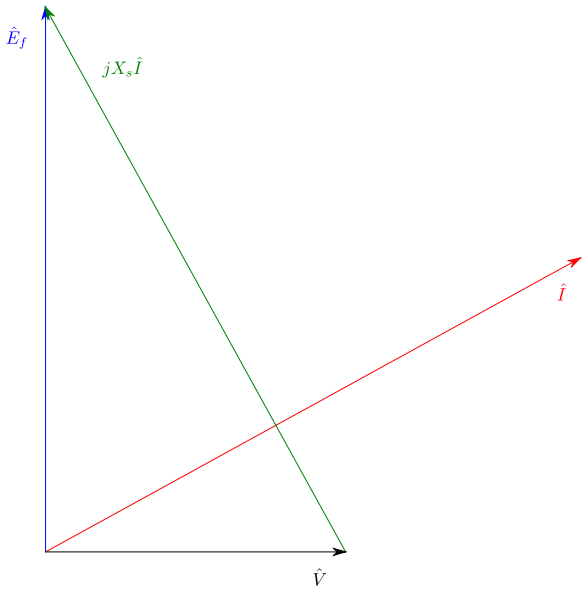
(d.i) 1,8 MW
(d.ii) 7,07 MW
(d.iii) 294,09 kN·m

6.11

(a) $\hat{E}_f$ = 14,68<26,61° kV



(b) 25,25 kN·m, 26,61°
(c) 17,80 MW
(d) 838,07 A, 0,876 (indutivo)



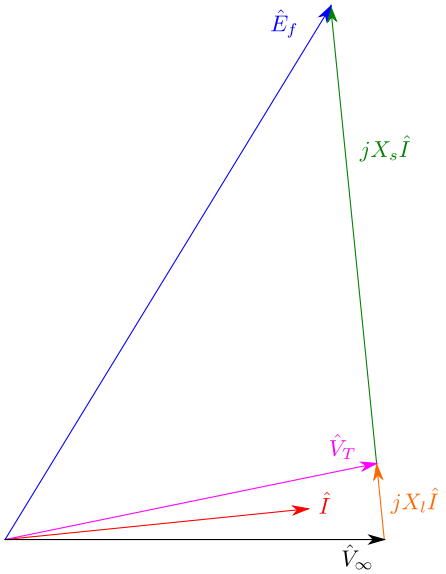
6.12

(a) E_f = 156,94 V, δ = 15,38°
(b) Redução de 19,01%

6.13

OBS: Considerar que a máquina opera injetando 400 MW (0,80 pu) de potência ativa para que a resposta seja a mesma do livro.

(a)



(b) 9,28 kA (0,8041 pu), 0,995 (capacitivo)
(c) 23,70<58,48° kV/fase (1,6423<58,48° pu)

6.14

(a) 2000 MW
(b) 285,71 MW

6.15

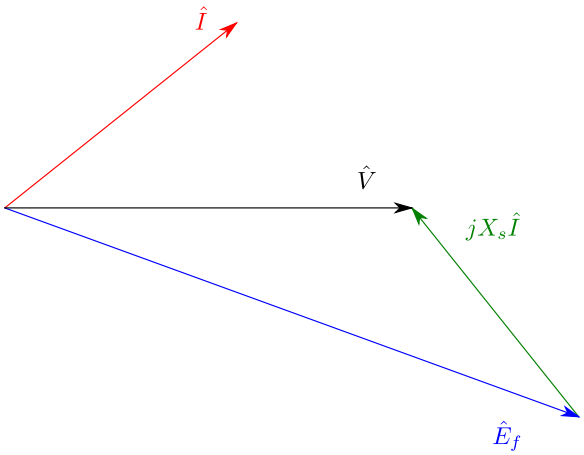
(a) 4 pólos
(b) X_s = 2,68 Ω, R_a = 0,0339 Ω
(c.i) 79,15 kN·m
(c.ii) 96,68%
(c.iii) 327,38 kW
(c.iv) 660 W
(c.v) $\hat{E}_f$ = 5222,8<-43,88° V/fase

6.16

(a) 0,266 pu
(b) 1257,6 V, -5,62°
(c) 477,07 A, 0,207 (indutivo). A máquina não perde o sincronismo.

6.17

OBS: Considerar o ângulo de $\hat{E}_f$ como δ_{ef} = -20,0° para que a resposta seja a mesma do livro.
(a) Motor
(b) 5,7 MW, 0,78 (indutivo)



6.18

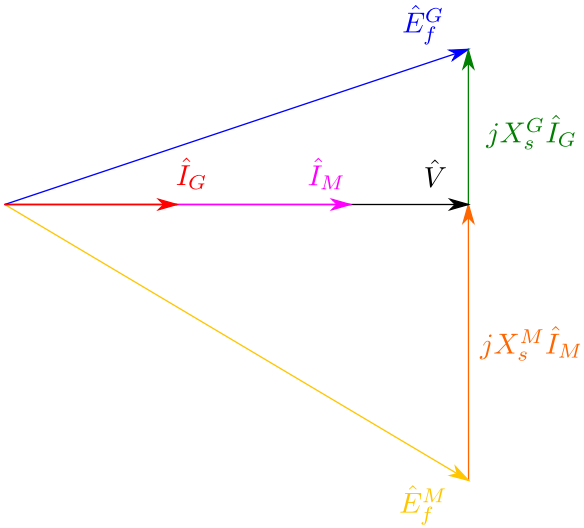
(a) 796,74 kW
(b) 984,32 kW, 15,67 kN·m, 384,88 A, 0,642 (indutivo)

6.19

(a) $\hat{E}_f$ = 1984,2<-23,54° V
($\hat{e}_f$ = 1,4942<-23,54° pu)
(b) 1,87 MW (1,87 pu), 24,77 kN·m (1,87 pu)
(c) Redução a 40% do valor original

6.20

(a) X_s^G = 4,76 Ω, X_s^M = 8,46 Ω
(b) $\hat{E}_f^G$ = 1400,7<18,56° V/fase (1,0548 pu), $\hat{E}_f^M$ = 1546,4<-30,83° V/fase (1,1645 pu)
(c)



OBS: A corrente do gerador é igual a corrente do motor ($\hat{I}_G = \hat{I}_M$ = 93,63<0,0° A), porém em pu na base de cada máquina, seus valores são diferentes visto que a potência nominal (base) de cada máquina é diferente.

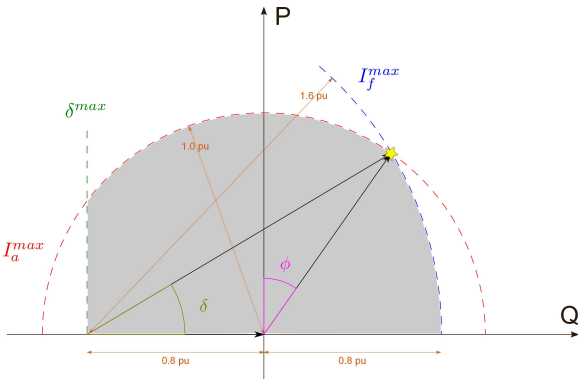
6.21

(a) I_a^{DC} = 0 A, $\hat{I}_a^{SM}$ = 10,01<-90,0° A, fp = 0 (capacitivo)
(b) I_a^{DC} = 36,36 A, $\hat{I}_a^{SM}$ = 22,72<-12,22° A, fp = 0,9773 (capacitivo)
(c) I_a^{DC} = -36,36 A, $\hat{I}_a^{SM}$ = -22,72<12,22° A, fp = 0,9773 (capacitivo)

OBS: Na convenção estabelecida, correntes positivas fluem do sistema DC para o sistema AC. Correntes negativas por sua vez fluem do sistema AC para o sistema DC.

6.22

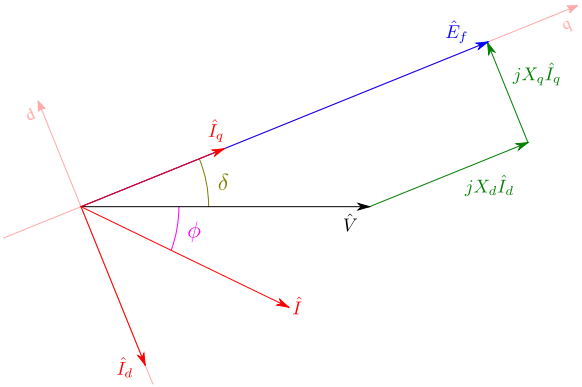
(a) 500 kVA
(b)



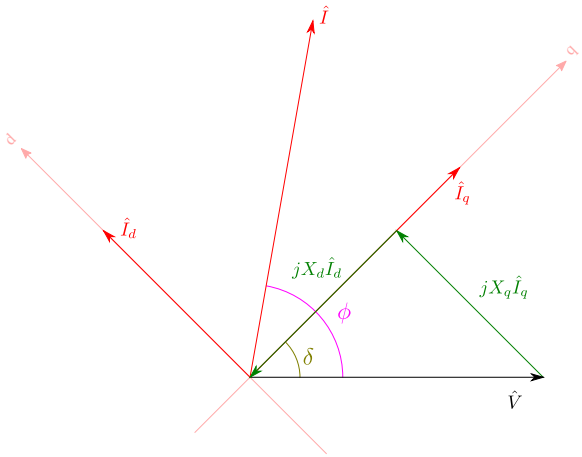
(c) 0,8182 (capacitivo), δ = 30,7535°

6.23

(a) E_f = 1,5204 pu, δ = 22,05°

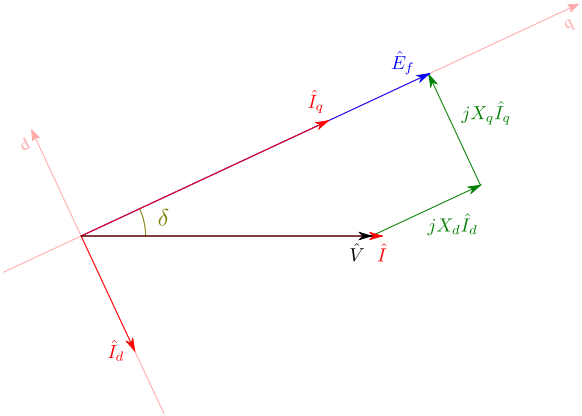


(b) 21,43 MW, 1,2330 pu, 0,1738 (indutivo)



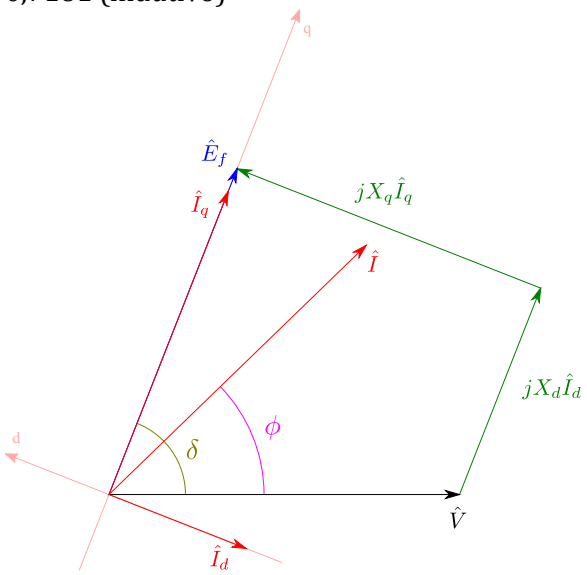
6.24

(a) $\hat{e}_f$ = 1,2990<25,0° pu, v = 0,9824<0,0° pu
(b) i_a = 1,0180 pu, i_d = 0,4302 pu, i_q = 0,9226 pu



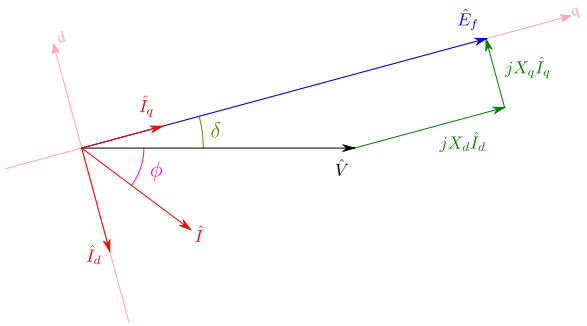
6.25

$p_{máx}$ = 0,7339 pu, $\hat{I}_a$ = 1,0221<44,10° pu, 0,7181 (indutivo)

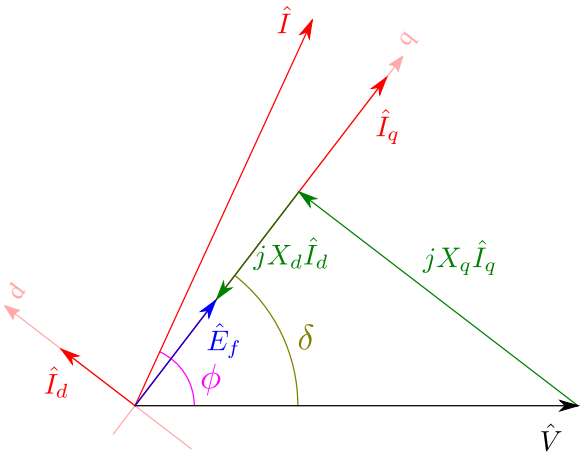


6.26

(a) E_f = 1,5367 pu, δ = 15,16°

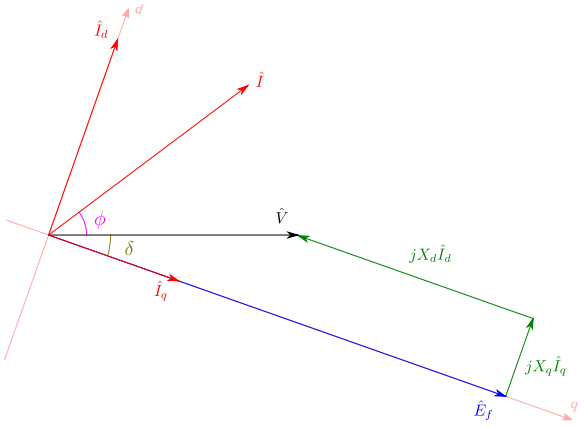


(b) E_f = 0,3014 pu, δ = 52,53°, I_a = 0,9574 pu, 0,4178 (indutivo)



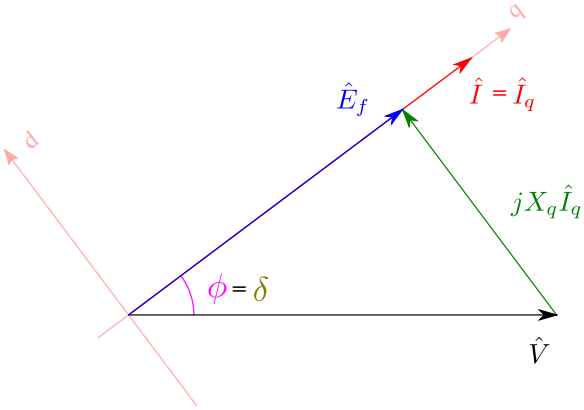
6.27

(a.i) E_f = 1,9415 pu, δ = -19,44°



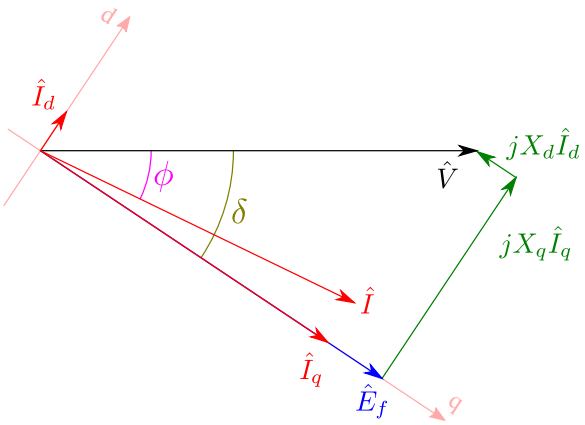
(a.ii) P_f = -0,5385 pu, P_r = -0,2615 pu

(b) E_f = 0,80 pu, δ = 36,87°

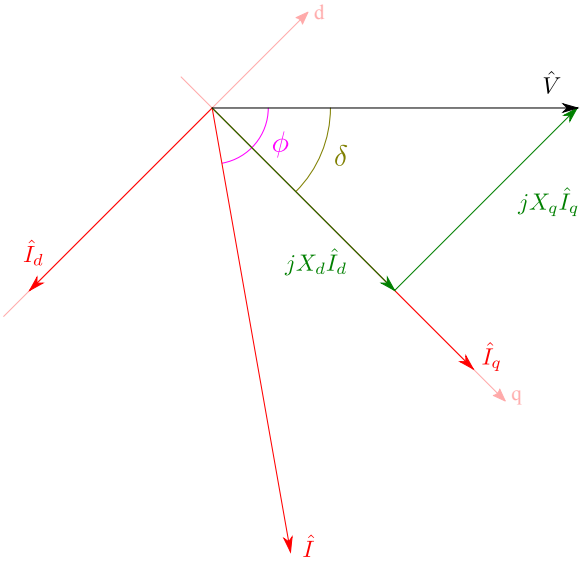


6.28

(a) E_f = 0,9413 pu, δ = -33,69°

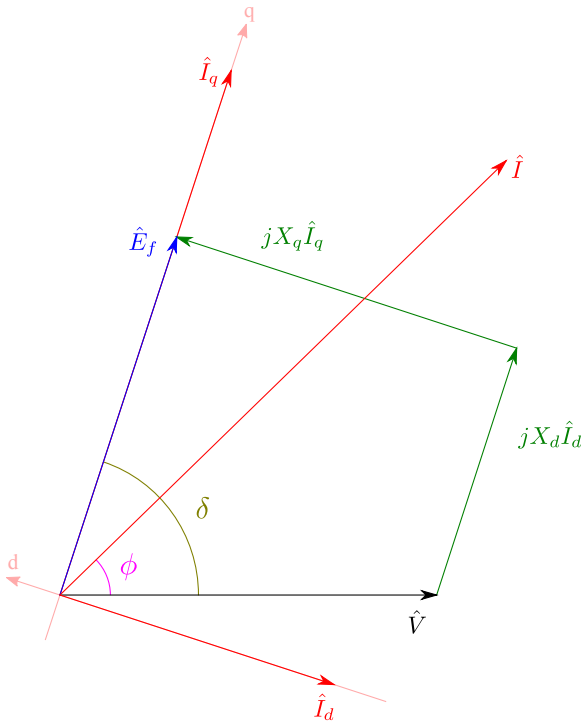


(b) 21,43 MW, 1,2330 pu, 0,1738 (indutivo)



6.29

$T_{máx}$ = 1,1823 pu, I_a = 1,6510 pu, 0,7161 (indutivo)



6.30

(a) E_f^{min} = 0,9000 pu
(b) E_f^{min} = 0,7817 pu

6.31

(a)
(b)
(c.i)
(c.ii)

6.32

(a)
(b)
(c)

6.33

(a)
(b)

6.34

(a)
(b)
(c)

6.35

(a)

P = 5 MW

If [A]	Ia [A]	FP
100.00	412.85	0.499
120.00	348.06	0.592
140.00	298.53	0.691
160.00	258.93	0.796
180.00	229.24	0.899
200.00	211.16	0.976
220.00	206.35	0.999
240.00	214.92	0.959
260.00	234.96	0.878
280.00	263.60	0.782
300.00	298.19	0.691
320.00	336.81	0.612
340.00	378.14	0.545
360.00	421.35	0.489
380.00	465.87	0.443
400.00	511.35	0.403
420.00	557.52	0.370
440.00	604.21	0.341
460.00	651.31	0.317
480.00	698.72	0.295
500.00	746.37	0.276
520.00	794.23	0.260
540.00	842.24	0.245
560.00	890.39	0.232
580.00	938.64	0.220
600.00	986.99	0.209

P = 10 MW

If [A]	Ia [A]	FP
170.00	597.46	0.690
190.00	495.24	0.833
210.00	450.95	0.914
230.00	425.82	0.968
250.00	414.07	0.996
270.00	413.28	0.998
290.00	421.78	0.978
310.00	438.04	0.941
330.00	460.67	0.895
350.00	488.42	0.844
370.00	520.23	0.793
390.00	555.23	0.743
410.00	592.76	0.696
430.00	632.26	0.652
450.00	673.35	0.612
470.00	715.69	0.576
490.00	759.04	0.543
510.00	803.22	0.513
530.00	848.07	0.486
550.00	893.47	0.462
570.00	939.34	0.439
590.00	985.59	0.418

P = 15 MW

If [A]	Ia [A]	FP
260.00	705.16	0.877
280.00	648.22	0.954
300.00	625.58	0.989
320.00	618.65	1.000
340.00	622.28	0.994
360.00	633.91	0.976
380.00	651.86	0.949
400.00	674.91	0.917
420.00	702.10	0.881
440.00	732.68	0.844
460.00	766.03	0.808
480.00	801.67	0.772
500.00	839.20	0.737
520.00	878.29	0.704
540.00	918.69	0.673
560.00	960.18	0.644
580.00	1002.59	0.617
600.00	1045.79	0.592

(b)