

ELEKTROTEHNIČKI FAKULTET U BEOGRADU
KATEDRA ZA ELEKTRONIKU

ENERGETSKA ELEKTRONIKA
LABORATORIJSKE VEŽBE

VEŽBA BROJ 5:
UPRAVLJANJE BUCK KONVERTOROM:
PROGRAMIRANJE STRUJE

IME I PREZIME	BR. INDEKSA	GRUPA	OCENA
1.			
2.			

DATUM _____

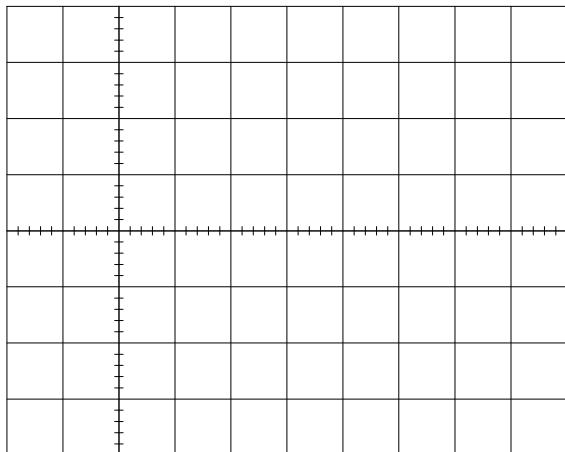
VREME _____

DEŽURNI U LABORATORIJU _____

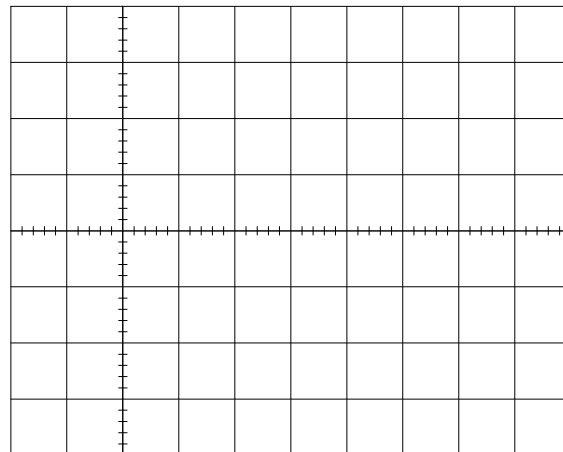
D.0

$$V_0 = \underline{\hspace{2cm}} \text{ V} \quad R_x = \underline{\hspace{2cm}} \Omega$$

D.1. Diskontinualni režim rada sa *hysteresis window* regulatorom



Slika 5.2. Struja kalema, $R_L = 470 \Omega$



Slika 5.3. Naizmenična komponenta izlaznog napona, $R_L = 470 \Omega$

Tabela 5.2. Subharmonijske oscilacije u diskontinualnom režimu

džamper	f_{SUB} [Hz]	$V_{out\ p-p}$
J7, 100 nF		
J8, 10 nF		
J9, 1 nF		

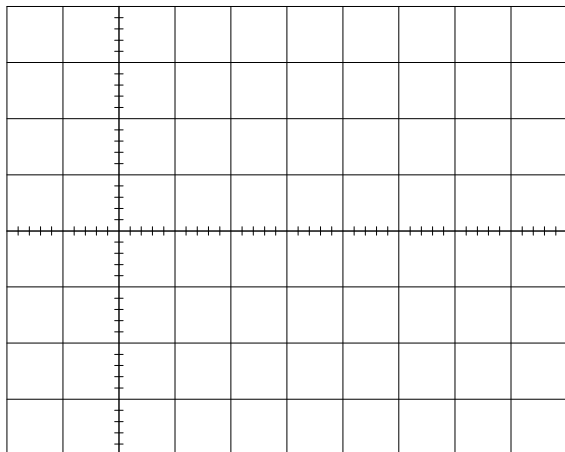
D.2. Zavisnost frekvencije prekidanja od izlaznog napona, *hysteresis window* regulator

Tabela 5.3. Zavisnost frekvencije prekidanja od izlaznog napona.

V_{OUT} [V]	f_s [kHz]
5	
6	
7	
8	
9	
10	

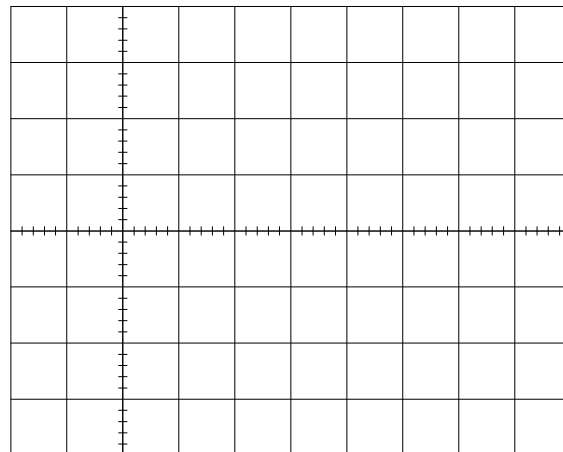
D.3. Dinamički odziv konvertora, *hysteresis window* regulator

D.3.1. Integralni regulator sa 100 nF.

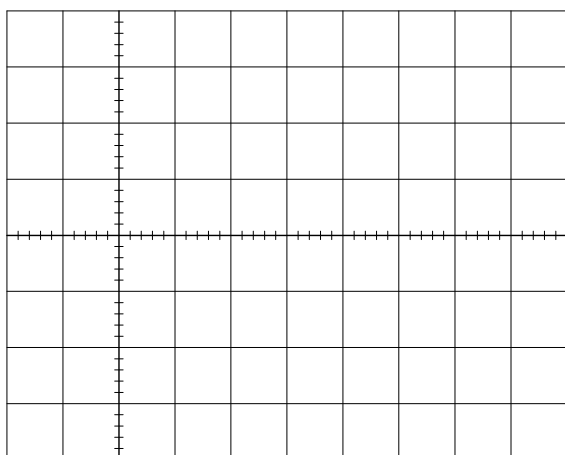


Slika 5.4. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$V_{out \, p-p} = \underline{\hspace{2cm}} \, \text{mV}$

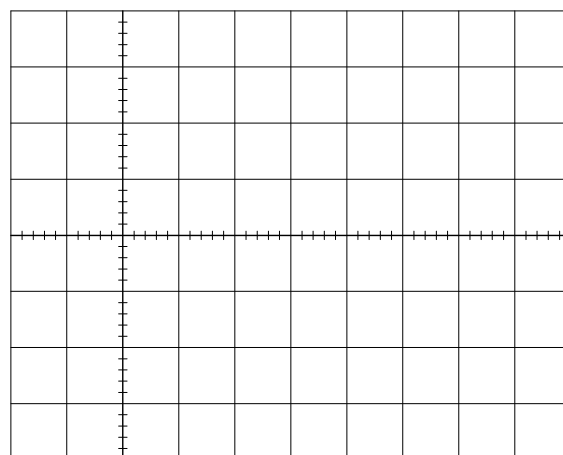


Slika 5.5. Naizmenična komponenta
izlaznog napona, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



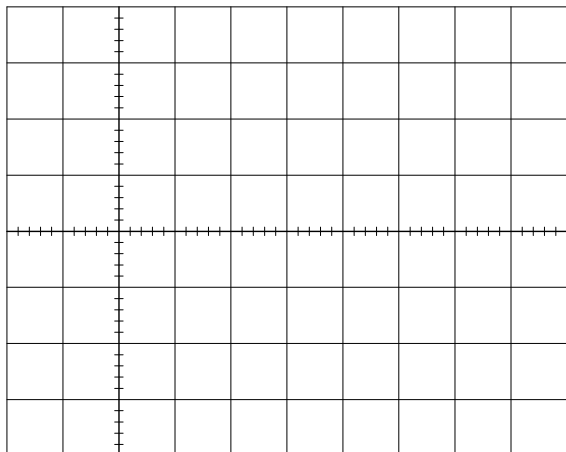
Slika 5.6. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$V_{out \, p-p} = \underline{\hspace{2cm}} \, \text{mV}$



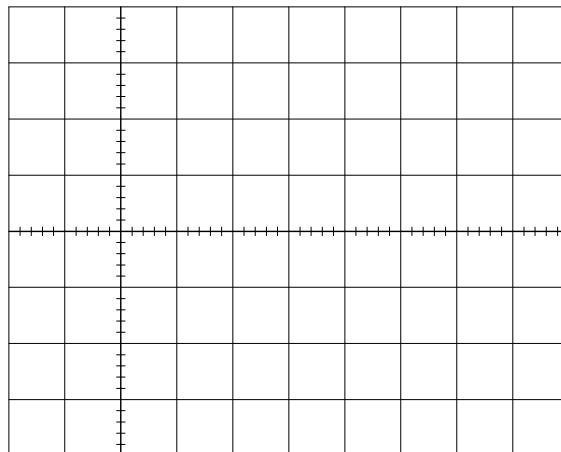
Slika 5.7. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$

D.3.2. Integralni regulator sa 10 nF.

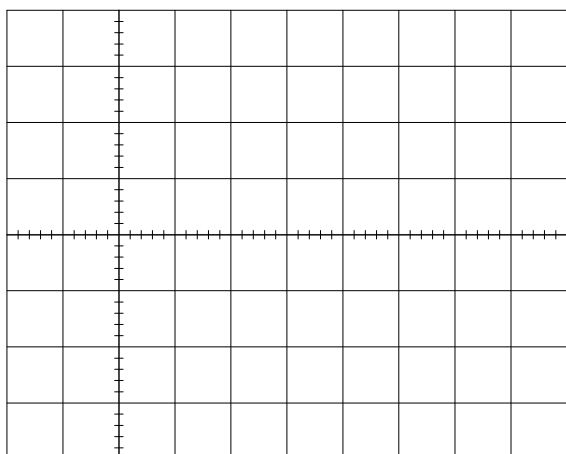


Slika 5.8. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$$V_{out \, p-p} = \text{_____} \, \text{mV}$$

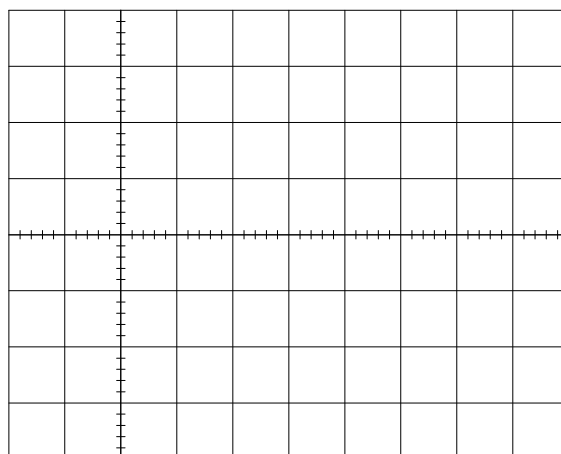


Slika 5.9. Naizmenična komponenta
izlaznog napona, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



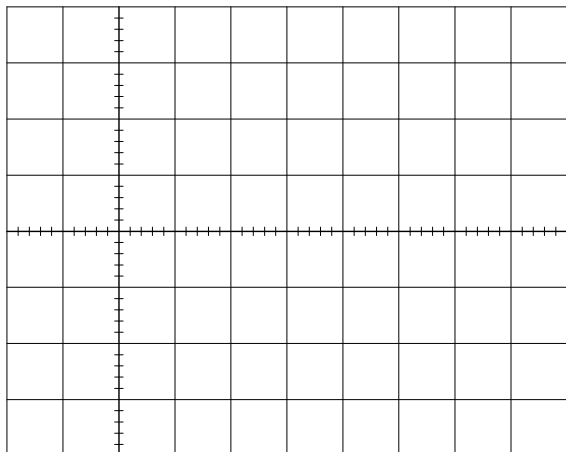
Slika 5.10. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$$V_{out \, p-p} = \text{_____} \, \text{mV}$$



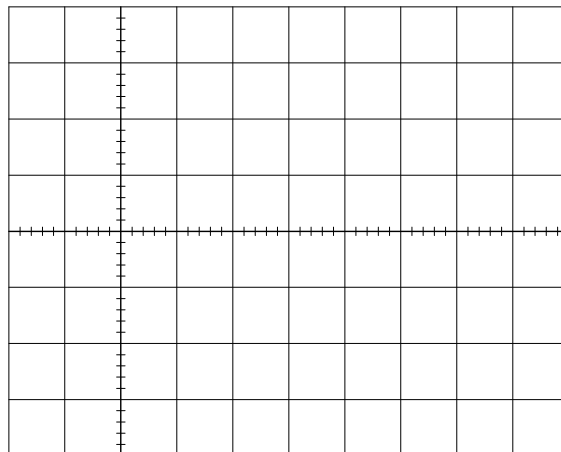
Slika 5.11. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$

D.3.3. Integralni regulator sa 1 nF.

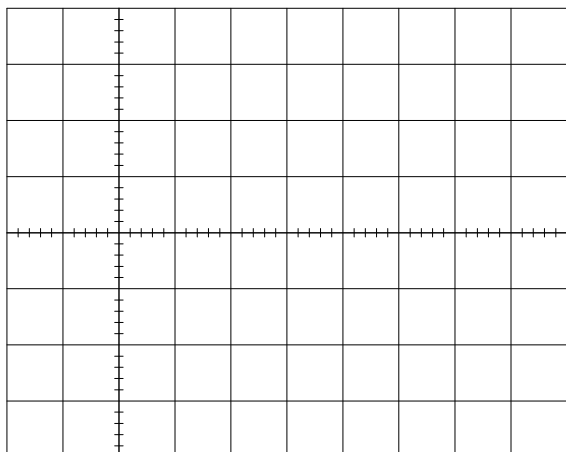


Slika 5.12. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$V_{out \, p-p} = \rule{1.5cm}{0.4pt} \text{ mV}$

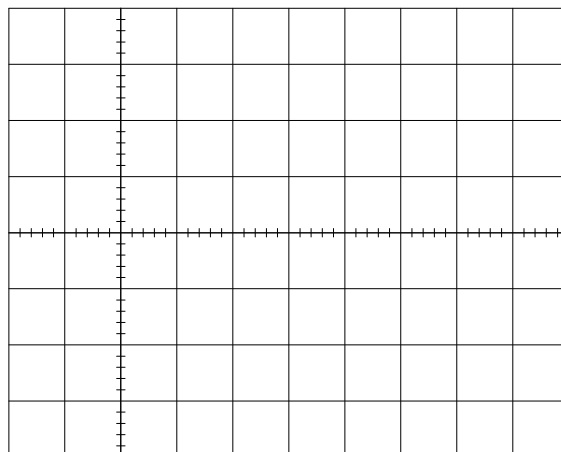


Slika 5.13. Naizmenična komponenta
izlaznog napona, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



Slika 5.14. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

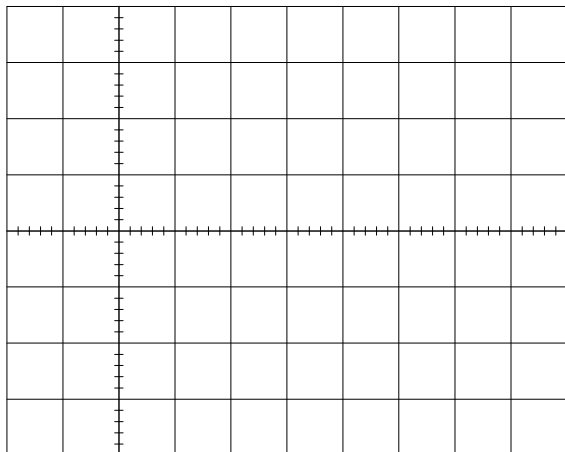
$V_{out \, p-p} = \rule{1.5cm}{0.4pt} \text{ mV}$



Slika 5.15. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$

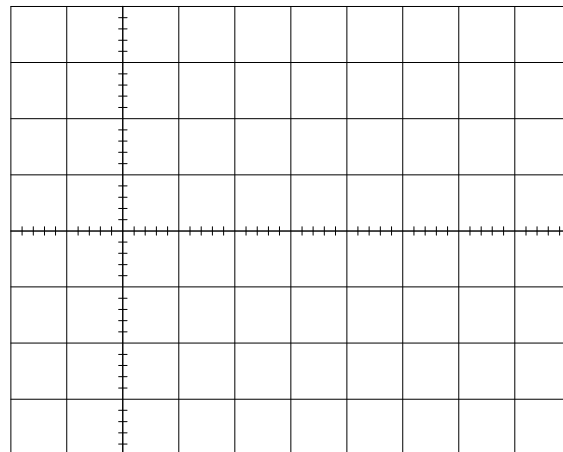
D.4. Proporcionalno-integralni regulator, *hysteresis window* regulator

D.4.1. Dinamički odziv konvertora.

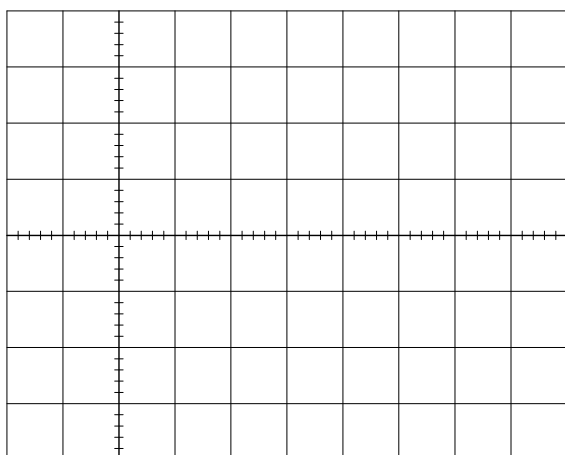


Slika 5.16. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$V_{out \, p-p} = \underline{\hspace{2cm}} \, \text{mV}$

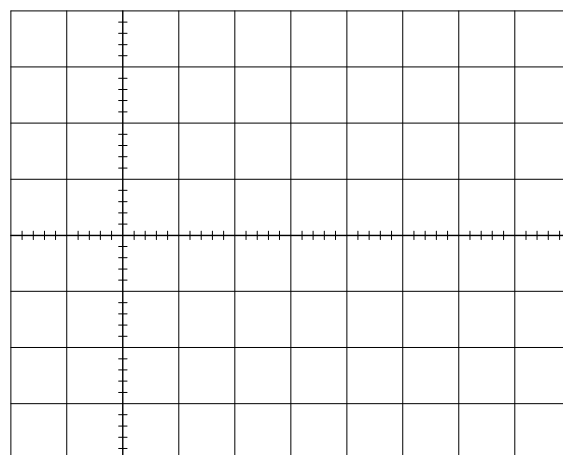


Slika 5.17. Naizmenična komponenta
izlaznog napona, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

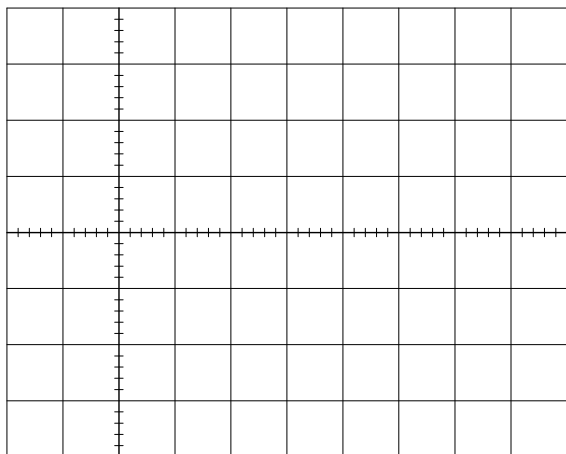


Slika 5.18. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

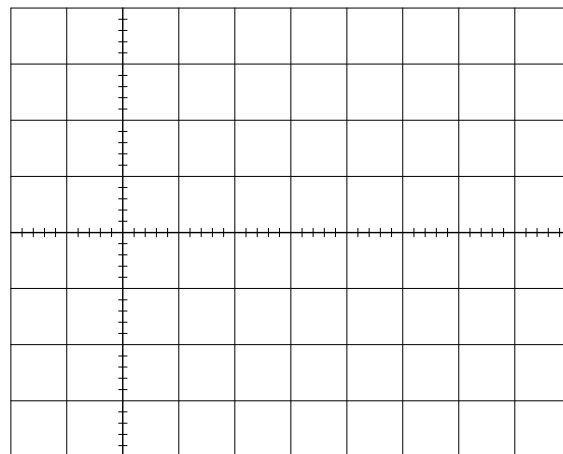
$V_{out \, p-p} = \underline{\hspace{2cm}} \, \text{mV}$



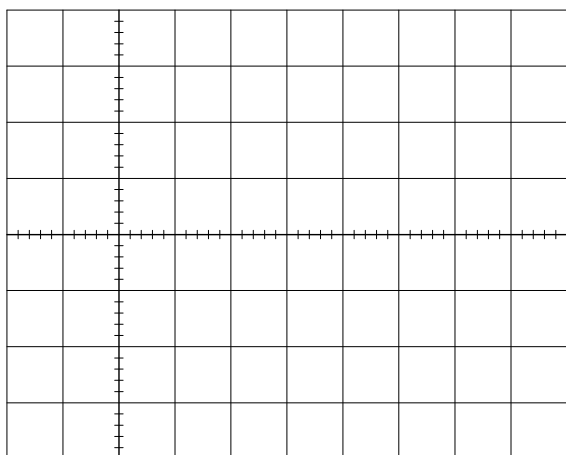
Slika 5.19. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$



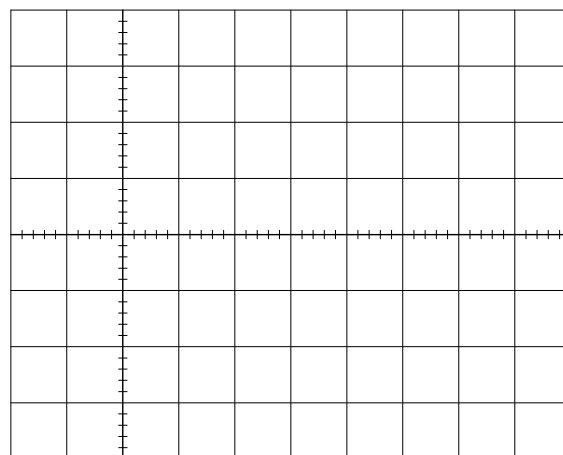
Slika 5.20. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



Slika 5.21. Naizmenična komponenta
izlaznog napona, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



Slika 5.22. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

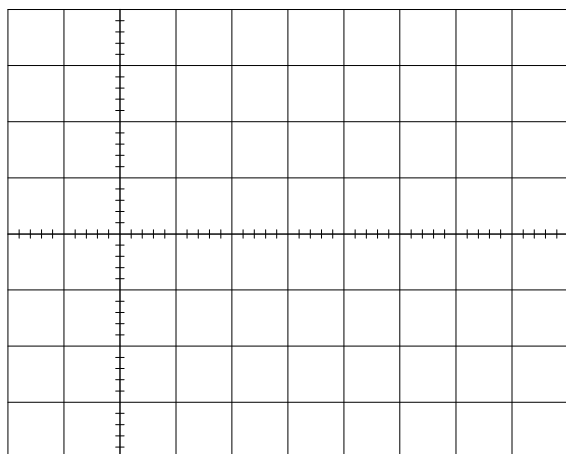


Slika 5.23. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$

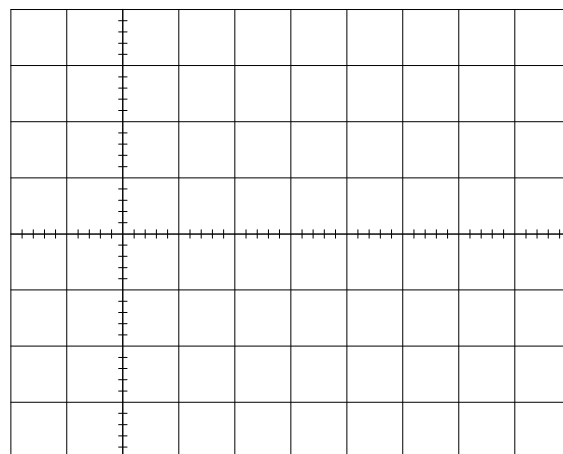
D.4.2. Zavisnost frekvencije prekidanja od konstante proporcionalnog dejstva.

Tabela 5.4. Zavisnost frekvencije prekidanja od konstante proporcionalnog dejstva

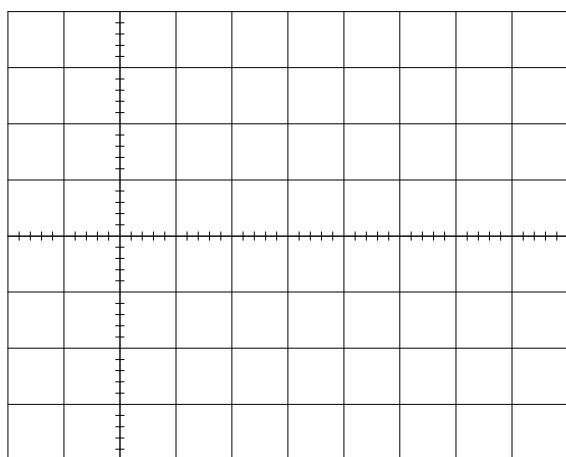
#	1	2	3	4	5	6	7	8	9	10	11
f_s [kHz]											



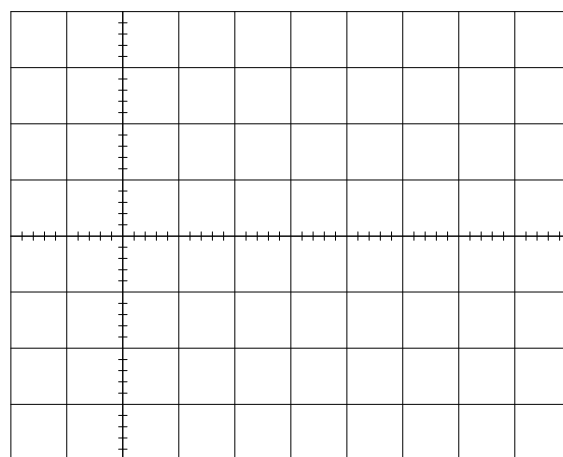
Slika 5.24. Struja kalema, min P2



Slika 5.25. Napon na izlazu regulatora,
min P2



Slika 5.26. Struja kalema, max P2



Slika 5.27. Napon na izlazu regulatora,
max P2

D.5. Stabilnost strujne petlje, *peak limiting* regulator

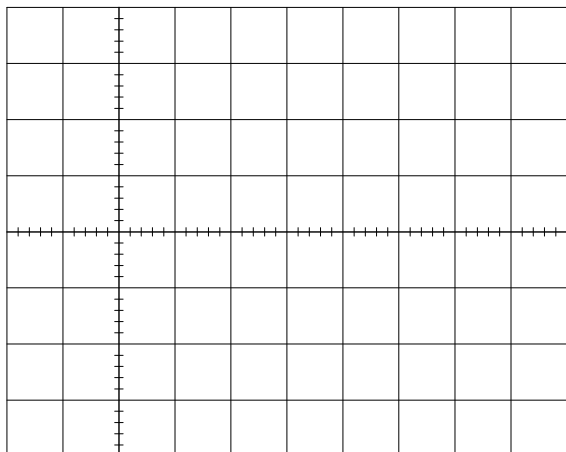
D.5.1. Stabilnost strujne petlje u diskontinualnom režimu.

$$D_{SUB} = \underline{\hspace{2cm}}, V_{OUT SUB} = \underline{\hspace{2cm}} \text{ V}$$

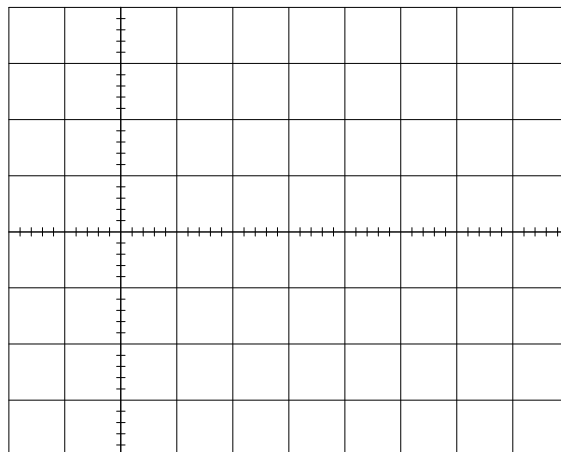
Zaključak:

D.5.2. Stabilnost strujne petlje u kontinualnom režimu.

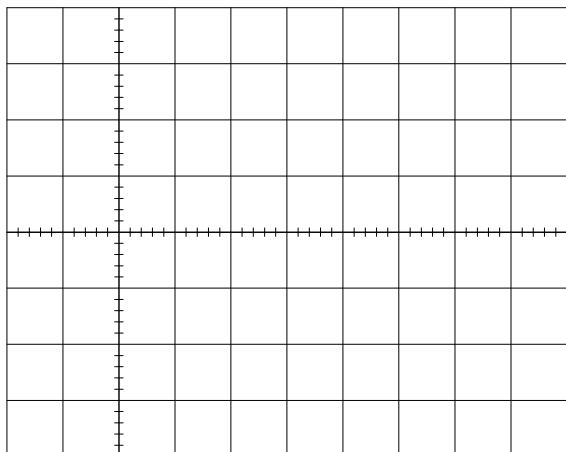
$$D_{SUB} = \underline{\hspace{2cm}}, V_{OUT SUB} = \underline{\hspace{2cm}} \text{ V}$$



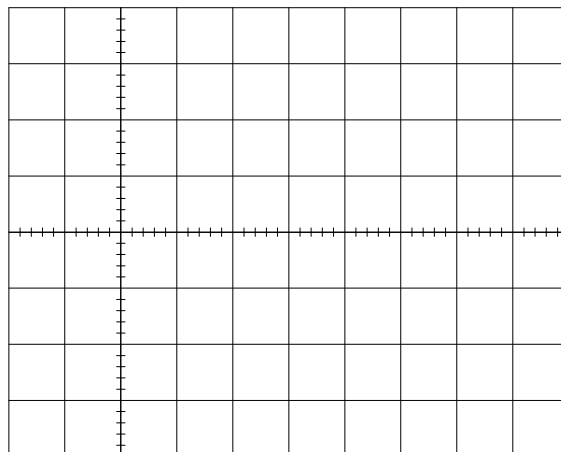
Slika 5.28. Napon na diodi konvertora, 5 V



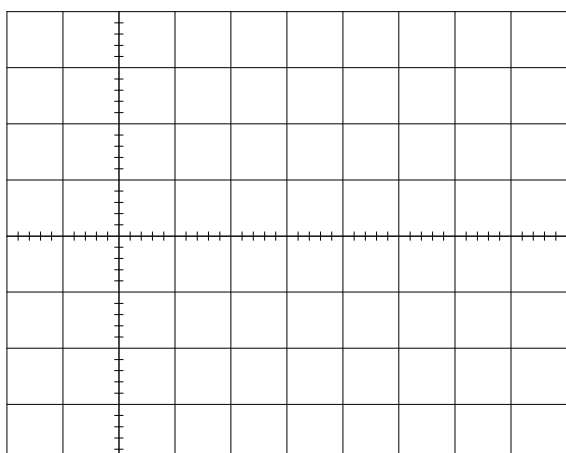
Slika 5.29. Struja kalema, 5 V



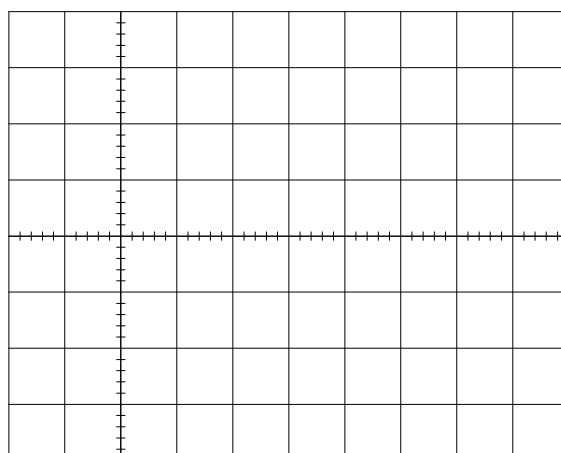
Slika 5.30. Napon na diodi konvertora, 8 V



Slika 5.31. Struja kalema, 8 V



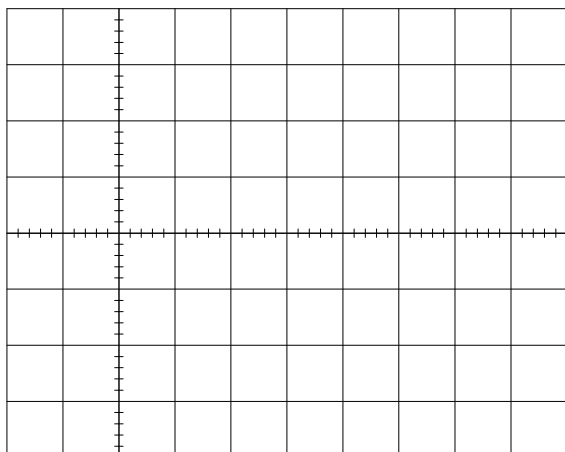
Slika 5.32. Napon na diodi konvertora,
10 V



Slika 5.33. Struja kalema, 10 V

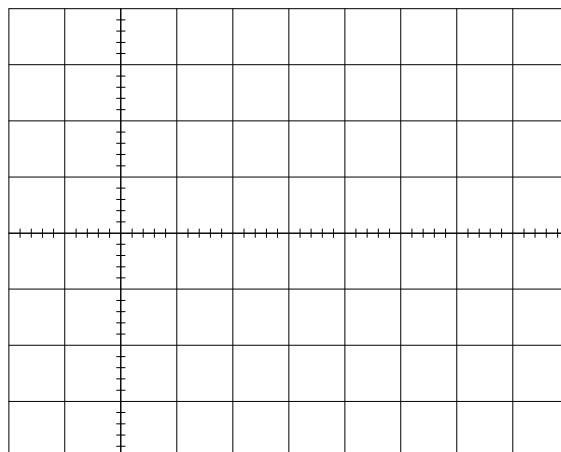
D.6. Dinamički odziv konvertora, *peak limiting* regulator

D.6.1. Integralni regulator sa 100 nF.

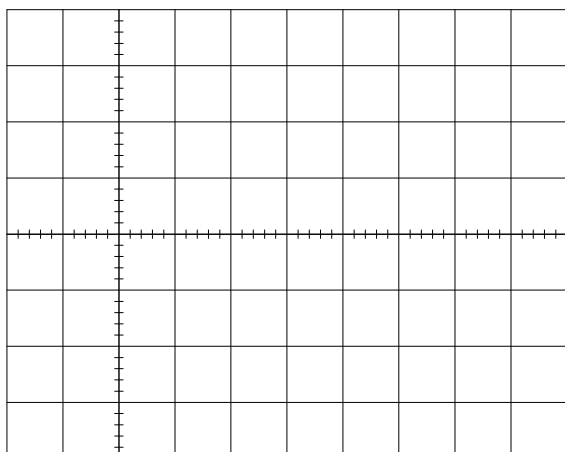


Slika 5.34. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$$V_{out \, p-p} = \text{_____} \, \text{mV}$$

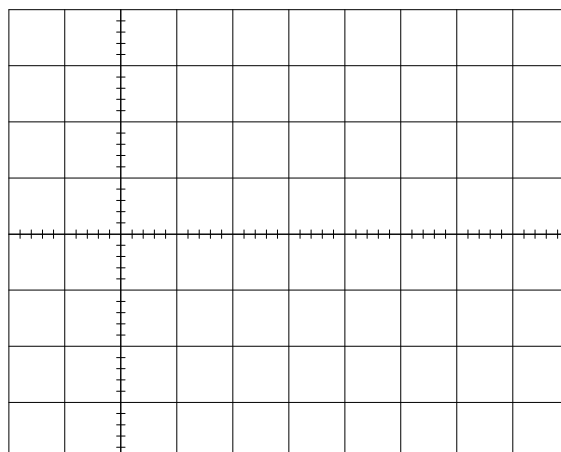


Slika 5.35. Naizmenična komponenta
izlaznog napona, isto



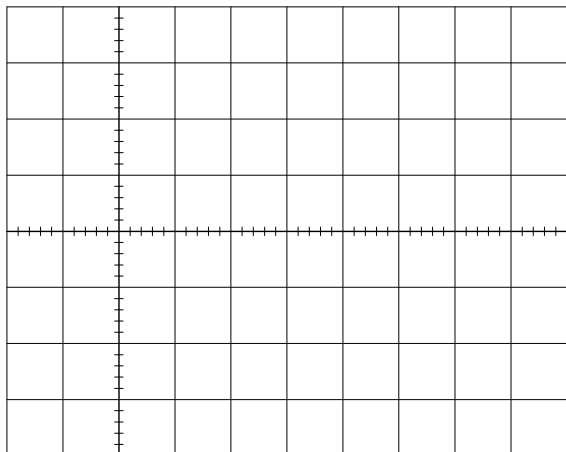
Slika 5.36. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$$V_{out \, p-p} = \text{_____} \, \text{mV}$$



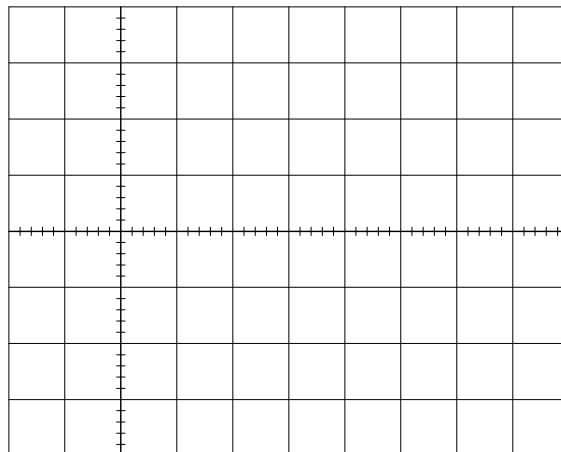
Slika 5.37. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$

D.6.2. Integralni regulator sa 10 nF.

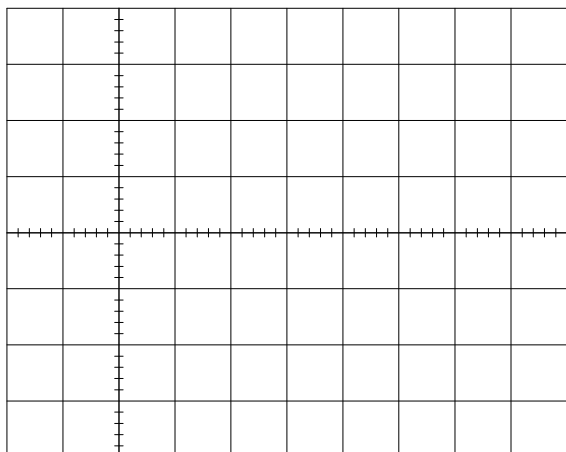


Slika 5.38. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$V_{out \, p-p} = \underline{\hspace{2cm}} \, \text{mV}$

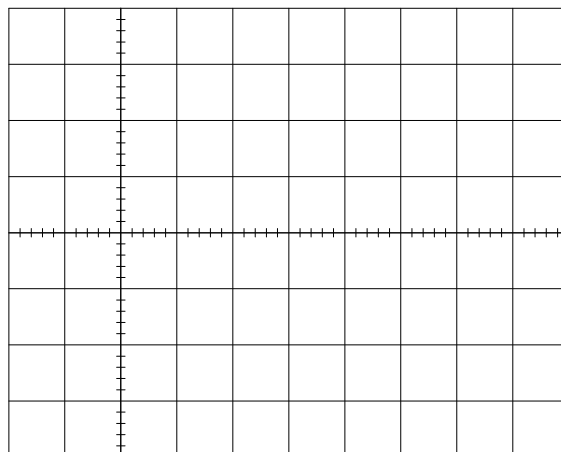


Slika 5.39. Naizmenična komponenta
izlaznog napona, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



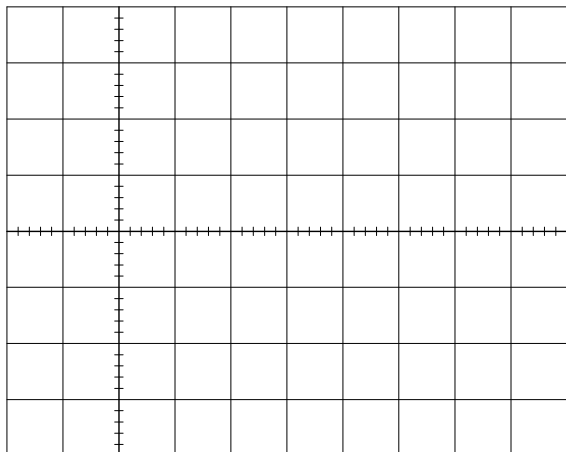
Slika 5.40. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$V_{out \, p-p} = \underline{\hspace{2cm}} \, \text{mV}$



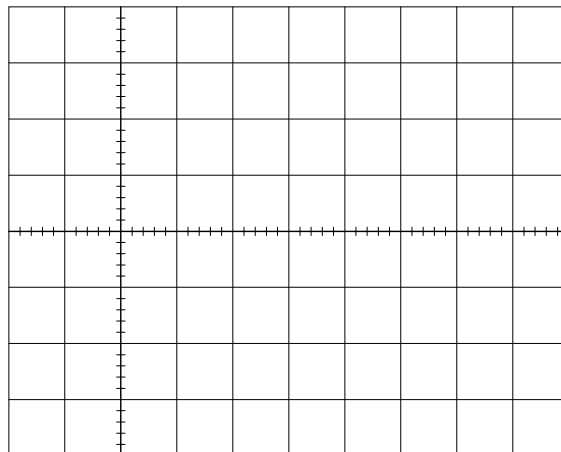
Slika 5.41. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$

D.6.3. Integralni regulator sa 1 nF.

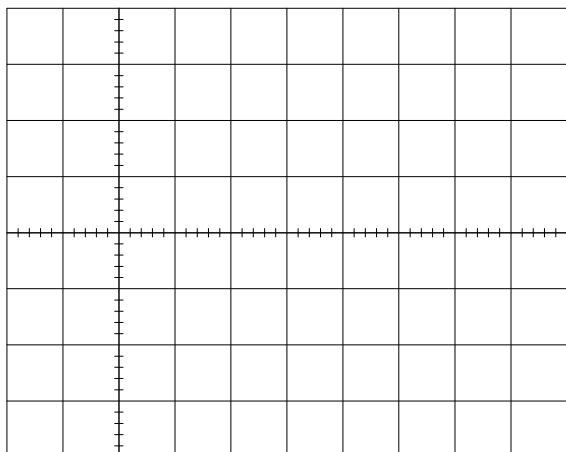


Slika 5.42. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$V_{out \, p-p} = \rule{1.5cm}{0.4pt} \text{ mV}$

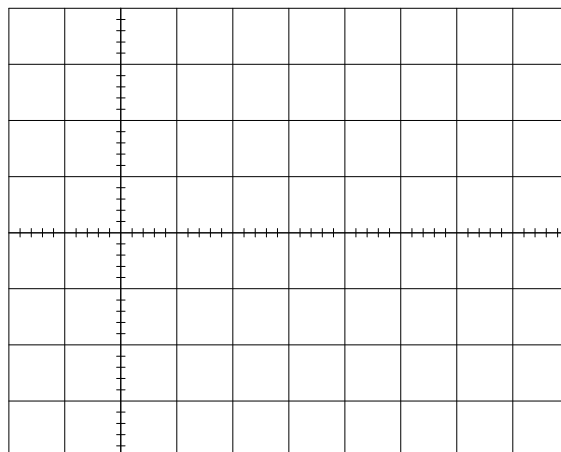


Slika 5.43. Naizmenična komponenta
izlaznog napona, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



Slika 5.44. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

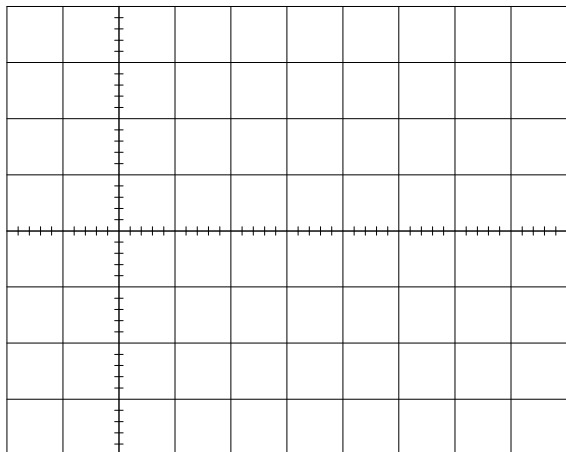
$V_{out \, p-p} = \rule{1.5cm}{0.4pt} \text{ mV}$



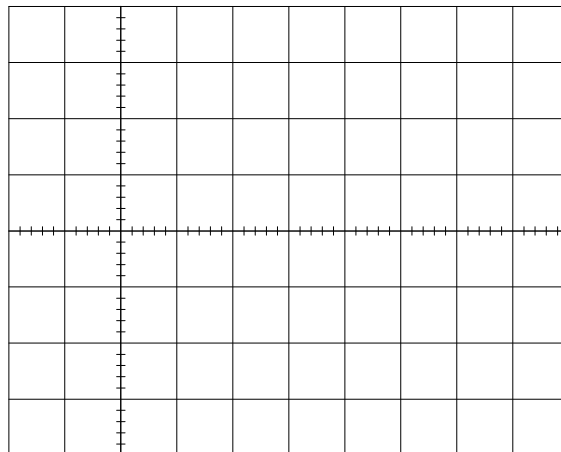
Slika 5.45. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$

D.7. Proporcionalno-integralni regulator, *peak limiting* regulator

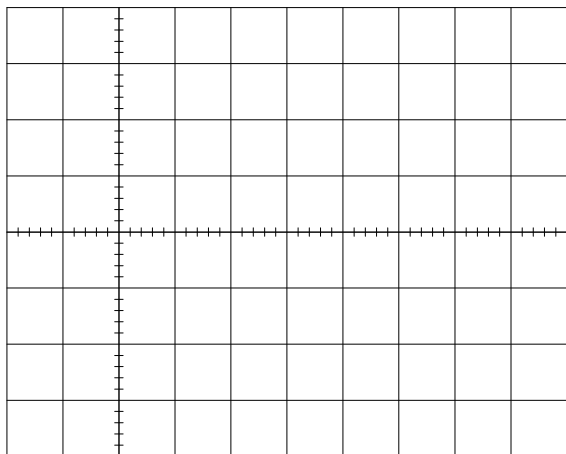
D.7.1. Subharmonijske oscilacije sa proporcionalno-integralnim regulatorom.



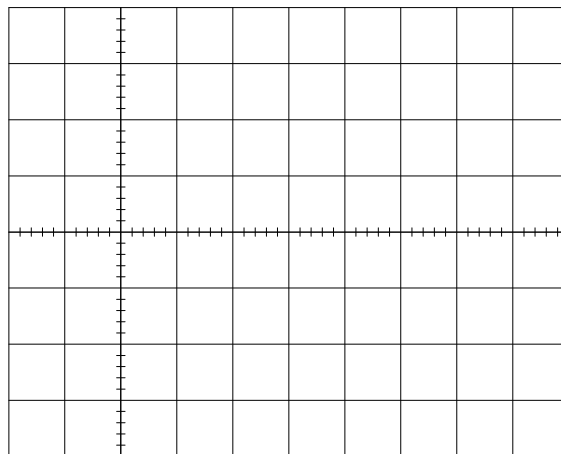
Slika 5.46. Struja kalema, P2 min



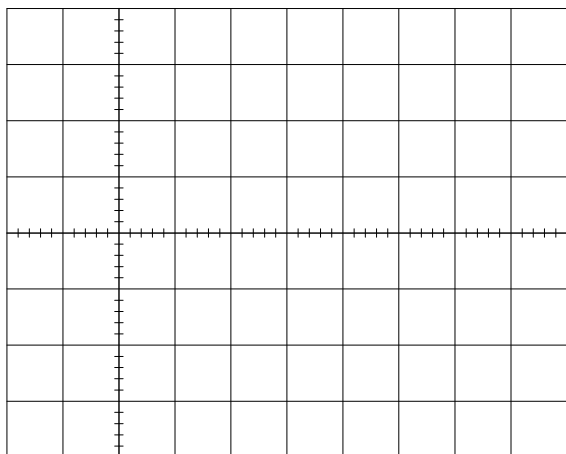
Slika 5.47. Napon na izlazu regulatora, P2 min



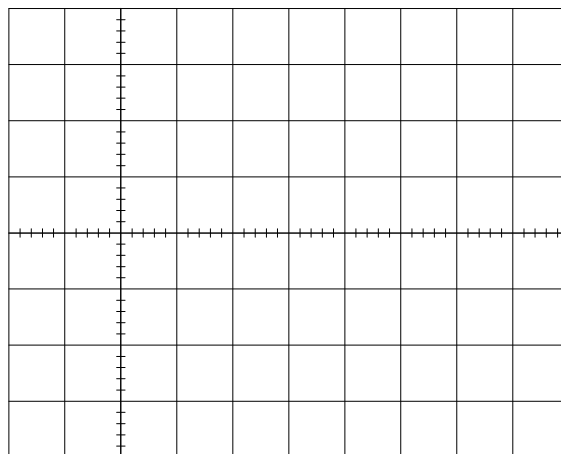
Slika 5.48. Struja kalema, P2 *sub*



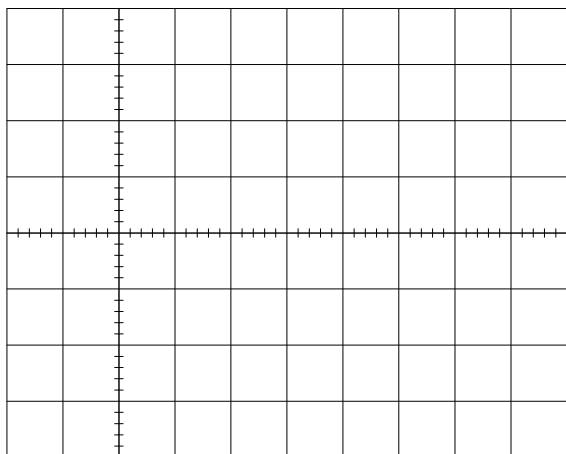
Slika 5.49. Napon na izlazu regulatora, P2 *sub*



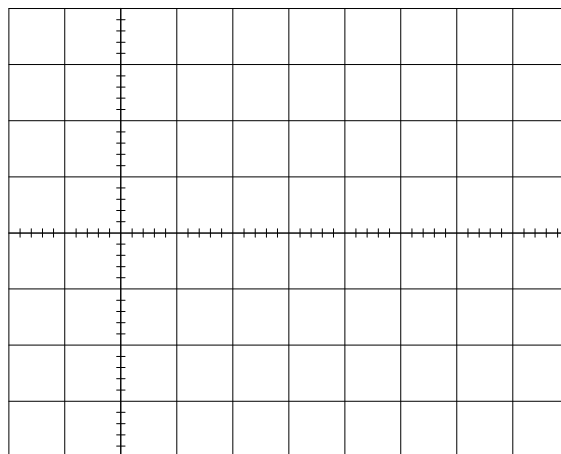
Slika 5.50. Struja kalema, P2 *doubl*



Slika 5.51. Napon na izlazu regulatora, P2 *doubl*



Slika 5.52. Struja kalema, P2 max

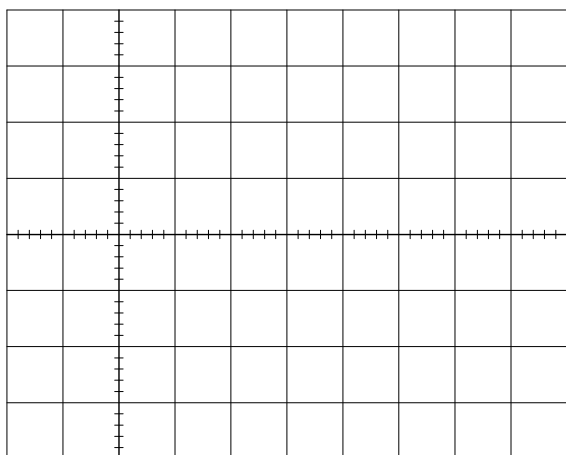


Slika 5.53. Napon na izlazu regulatora, P2 max

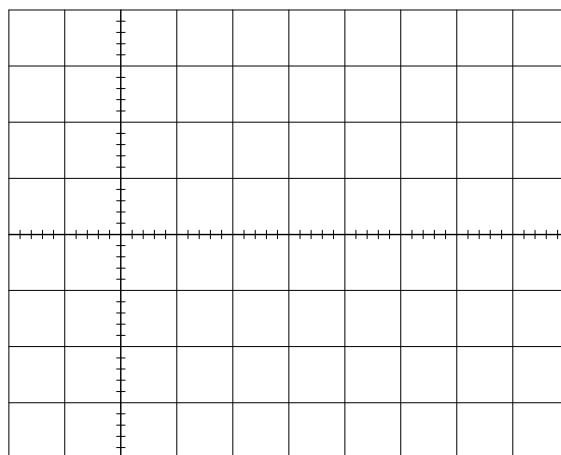
D.7.2. Eliminacija subharmonijskih oscilacija kod proporcionalno-integralnog regulatora uvođenjem dodatnog pola.

Zaključak:

D.7.3. Dinamički odziv konvertora.

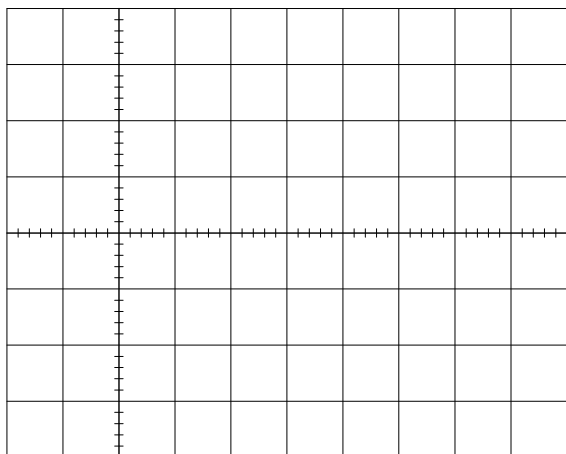


Slika 5.54. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



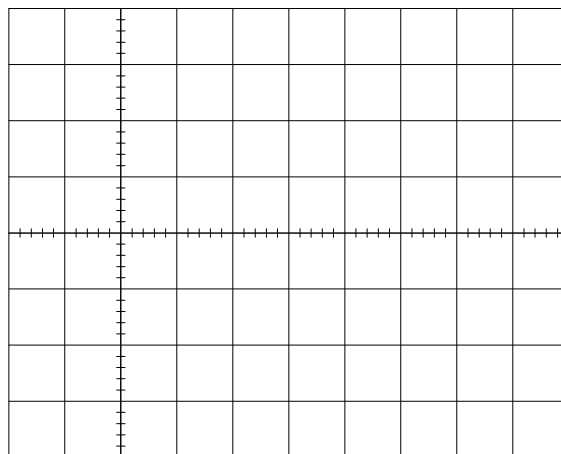
Slika 5.55. Naizmenična komponenta
izlaznog napona, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

$V_{out \, p-p} = \underline{\hspace{2cm}} \, \text{mV}$

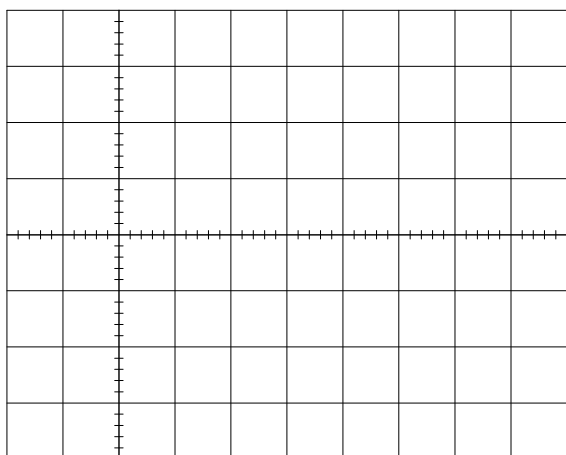


Slika 5.56. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$

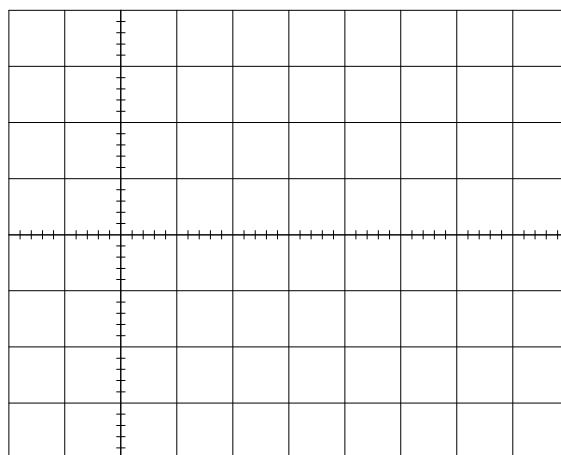
$V_{out \, p-p} = \underline{\hspace{2cm}} \, \text{mV}$



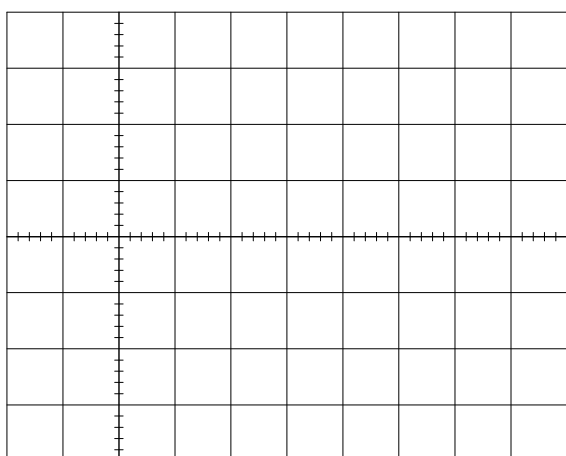
Slika 5.57. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$



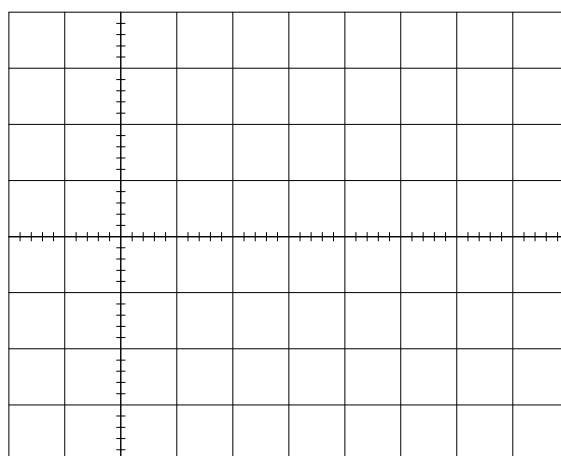
Slika 5.58. Struja kalema, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



Slika 5.59. Naizmenična komponenta
izlaznog napona, $R_L = 16,5 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



Slika 5.60. Struja kalema, $R_L = 47 \, \Omega$,
 $R_{L2} = 8,2 \, \Omega$



Slika 5.61. Naizmenična komponenta
izlaznog napona, $R_L = 47 \, \Omega$, $R_{L2} = 8,2 \, \Omega$

Zaključak: