



Fakultet elektrotehnike, računarstva i  
informatičkih tehnologija Osijek

# UZEMLJIVAČI I SUSTAVI UZEMLJENJA

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Zavod za elektroenergetiku  
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# OPĆE INFORMACIJE KOLEGIJA

Nositelj predmeta	Izv.prof.dr.sc. Goran Knežević	
Naziv predmeta	Uzemljivači i sustavi uzemljenja	
Studijski program	Diplomski sveučilišni studij Elektrotehnika, smjer Elektroenergetika	
Status predmeta	Izborni	
Godina	Druga	
Bodovna vrijednost i način izvođenja nastave	ECTS koeficijent opterećenja studenata	5
	Broj sati (P+LV+KV)	30+15+15

# Ciljevi predmeta

- Studentima objasniti dimenzioniranje sustava uzemljenja elektroenergetskih postrojenja
- Studente osposobiti za samostalni izračun i mjerenje otpora uzemljenja elektroenergetskih postrojenja.

# *Očekivani ishodi učenja za predmet*

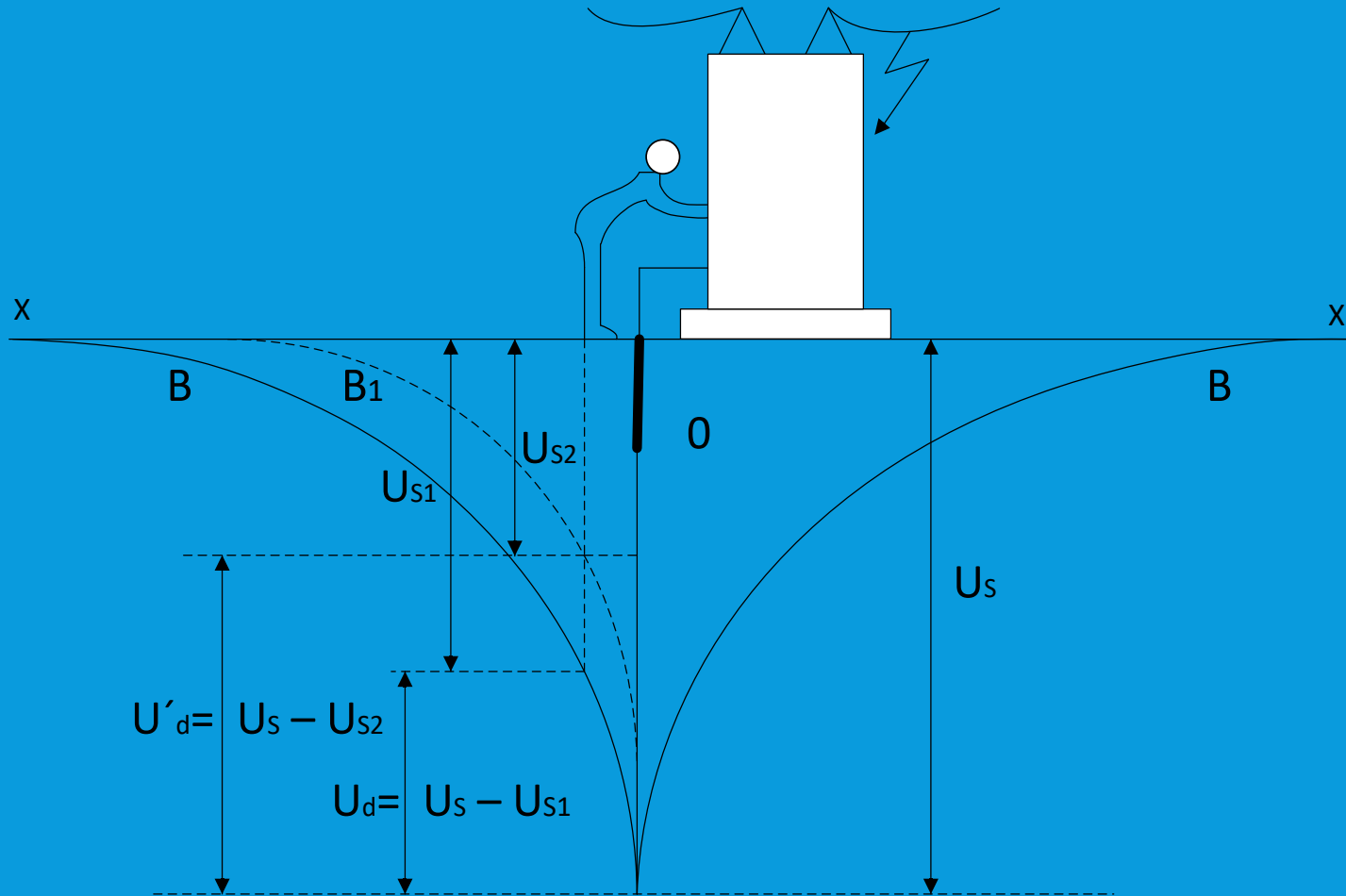
1. definirati osnovne pojmove uzemljivača i sustava uzemljenja
2. napraviti izračun otpora uzemljenja štapnih, trakastih, temeljnih i mrežastih uzemljivača
3. analizirati sastavljene uzemljivače načinjene kombinacijom skupina trakastih i štapnih uzemljivača
4. izmjeriti otpor uzemljenja elektroenergetskih visokonaponskih postrojenja
5. napraviti proračun otpora uzemljenja i razdiobe potencijala složenih sustava uzemljenja elektroenergetskih postrojenja primjenom računalnog programa

AKTIVNOST STUDENTA	ECTS	ISHOD UČENJA	NASTAVNA METODA	METODA PROCJENE	BODOVI	
					Min	max
Pohađanje: Predavanja (PR), Laboratorijske vježbe (LV), Konstrukcijske vježbe (KV)	1	1,2,3	Predavanja (PR), Laboratorijske vježbe (LV), Konstrukcijske vježbe (KV)	Evidentiranje nazočnosti. Minimum potreban za potpis iznosi: 70%.	3	5
Analiza rezultata LV	1.5	4,5	Laboratorijske vježbe (LV)	Nadzor provođenja LV-a, provjera napisanih izvještaja	8	15
Priprema za usmeni ispit i usmeno odgovaranje na pitanja	1.5	1,2,3,5	Usmeni ispit	Provjera danih odgovora	25	50
Rješavanje problema zadanog na KV	1	2,3,5	Konstrukcijske vježbe (KV)	Vrednovanje rješenja za zadani problem	15	30

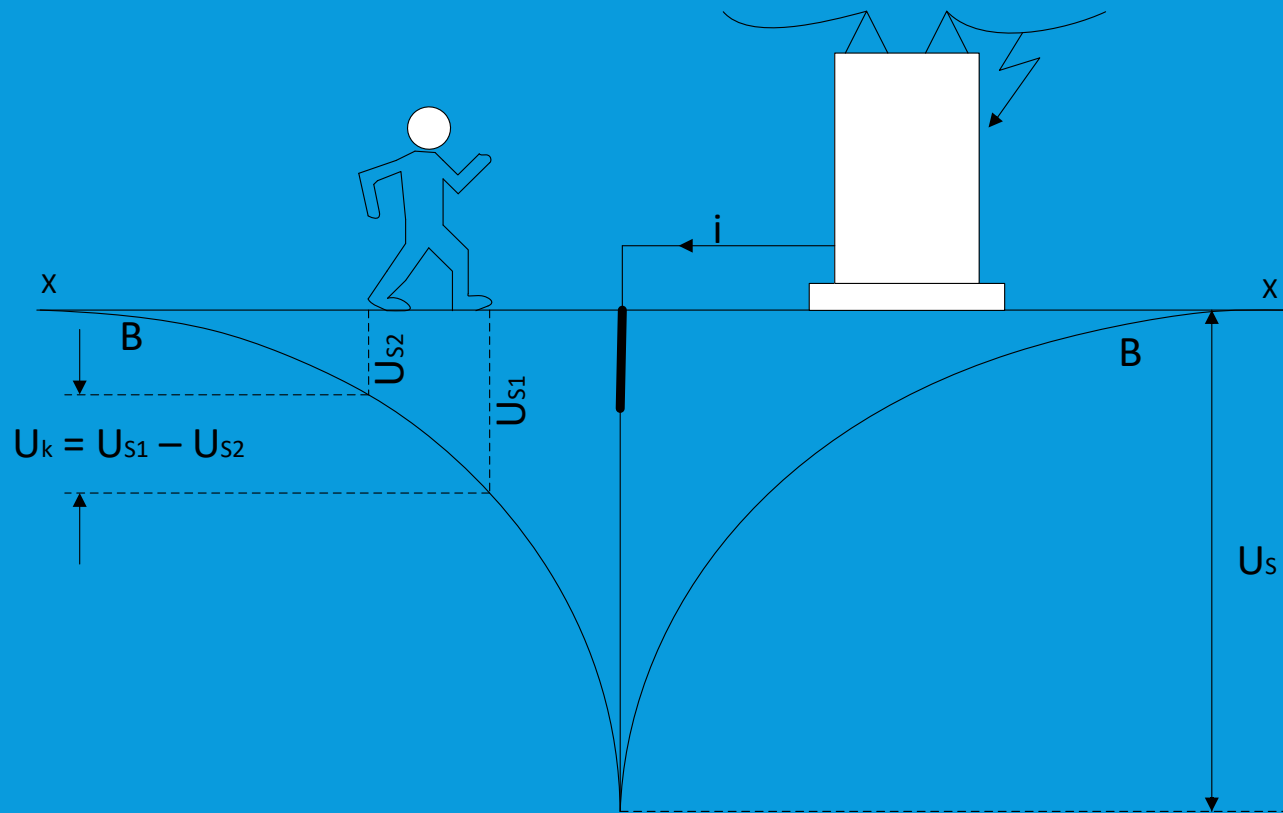
# SADRŽAJ

1. OSNOVNI POJMOVI
2. KARAKTERISTIKE TLA
3. IZRAČUN OTPORA UZEMLJENJA
4. IMPULSNI UZEMLJIVAČI
5. TOPLINSKI PRORAČUN UZEMLJIVAČA
6. MJERENJE OTPORA UZEMLJENJA
7. UZEMLJENJE OGRADE ELEKTROENERGETSKOG POSTROJENJA
8. ANALIZA UZEMLJENJA PROŠIRENE TIPSKE TRAFOSTANICE  
(PTTS) 10(20)/0.4 KV

# *Napon dodira*

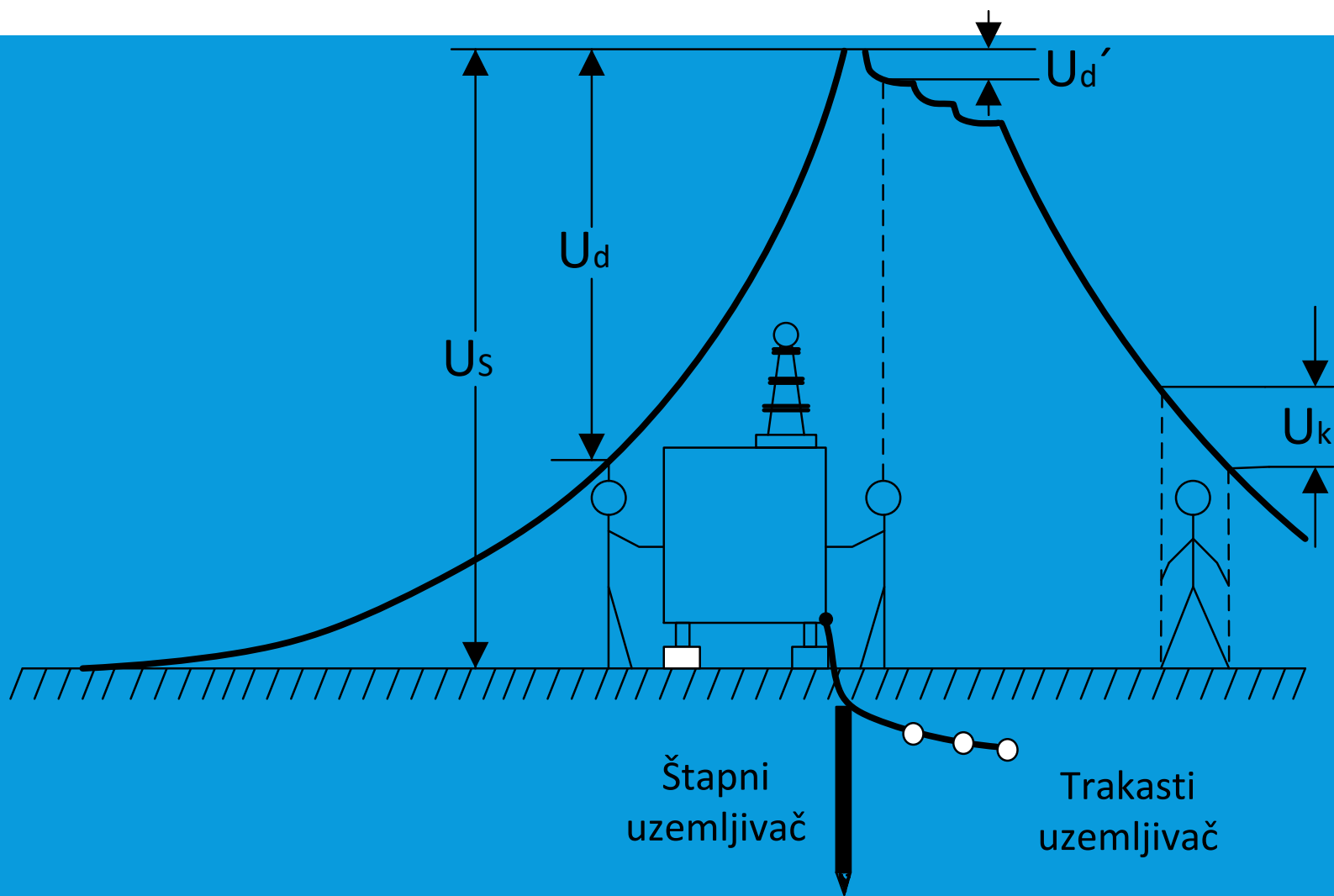


# Napon koraka

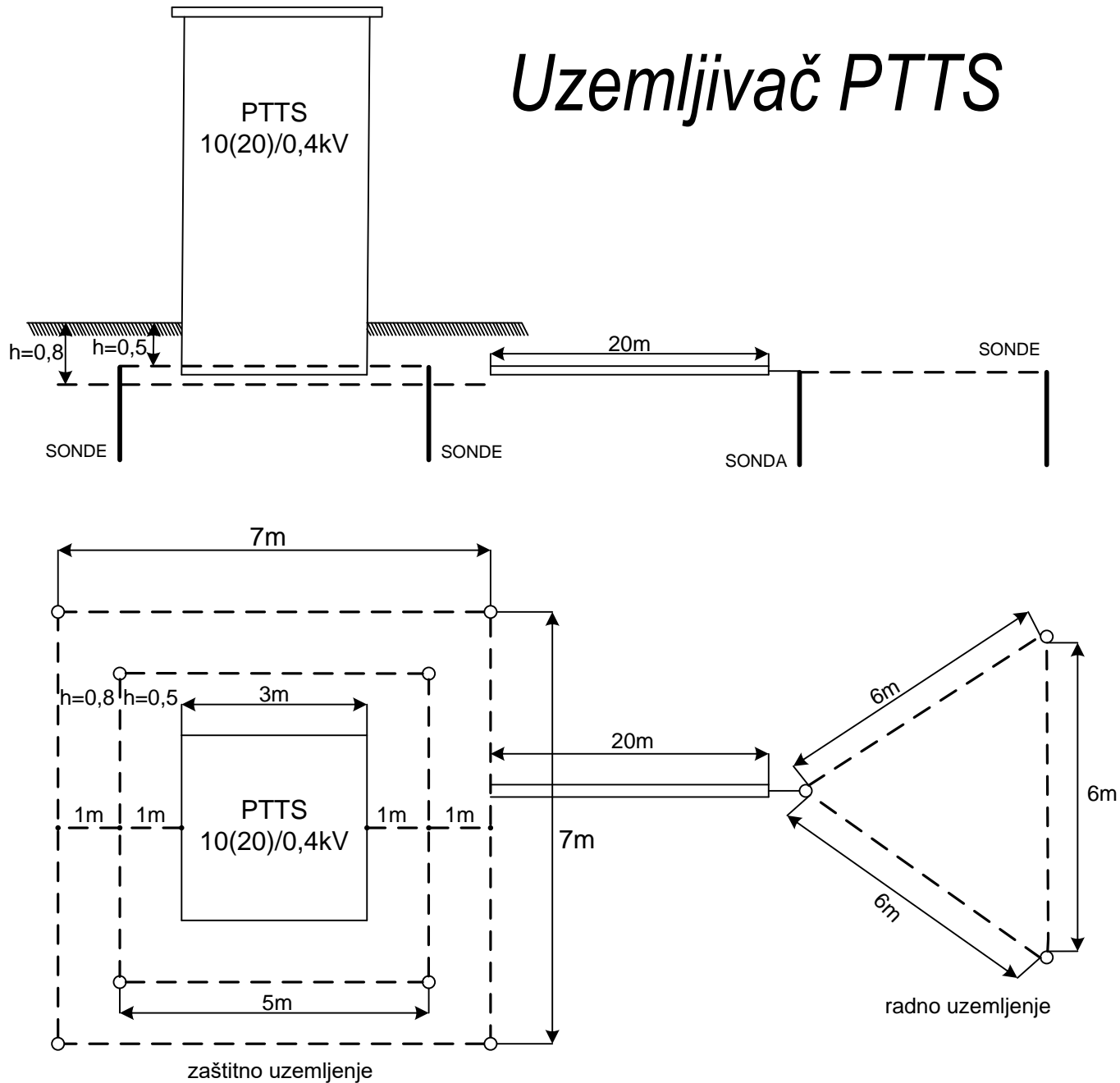




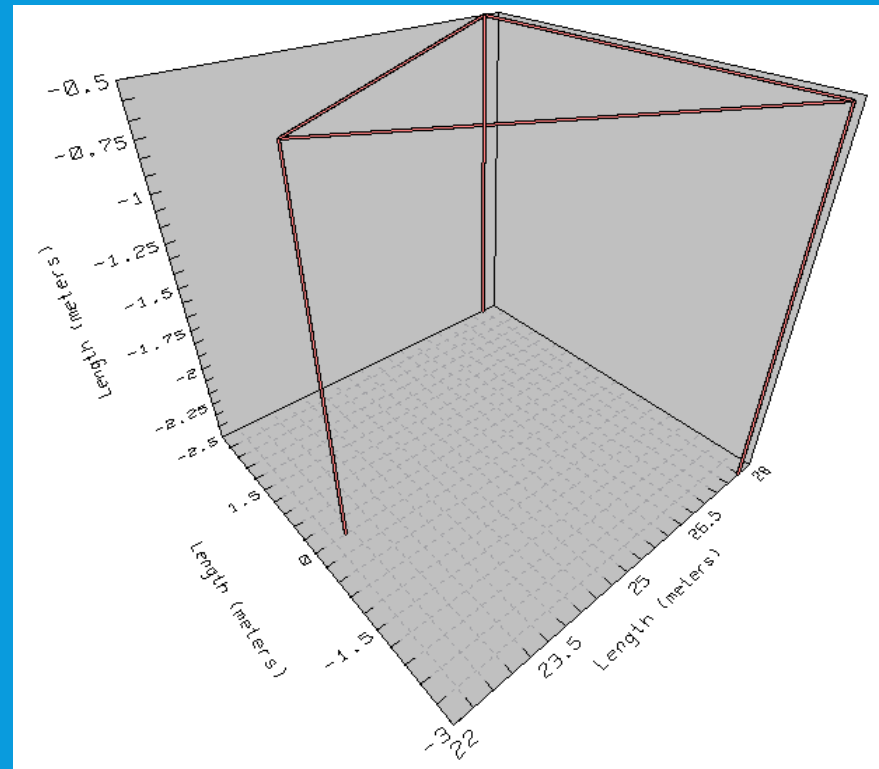
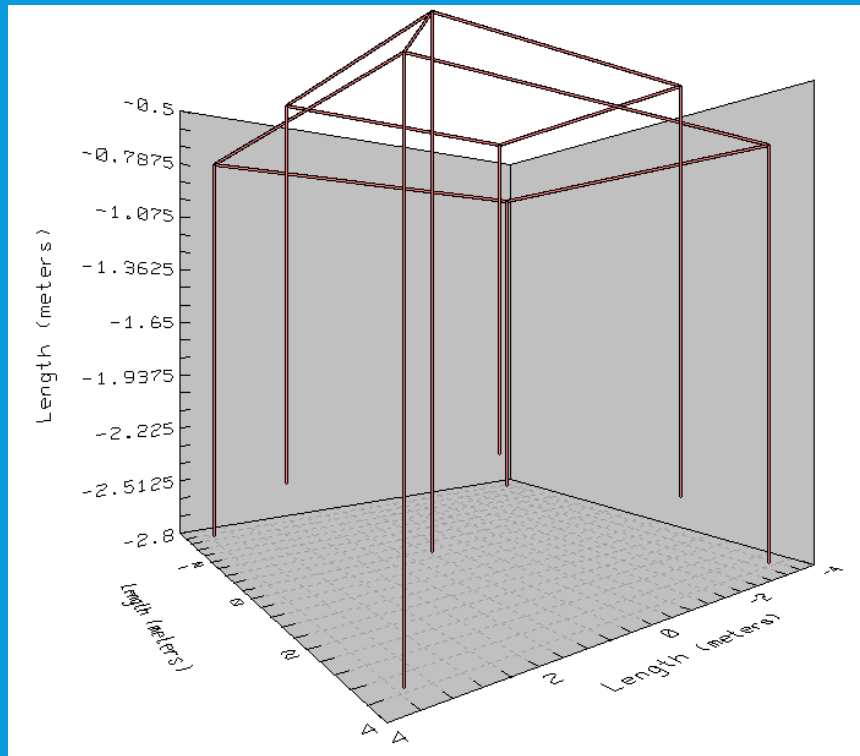
# Oblikovanje potencijalnog lijevka



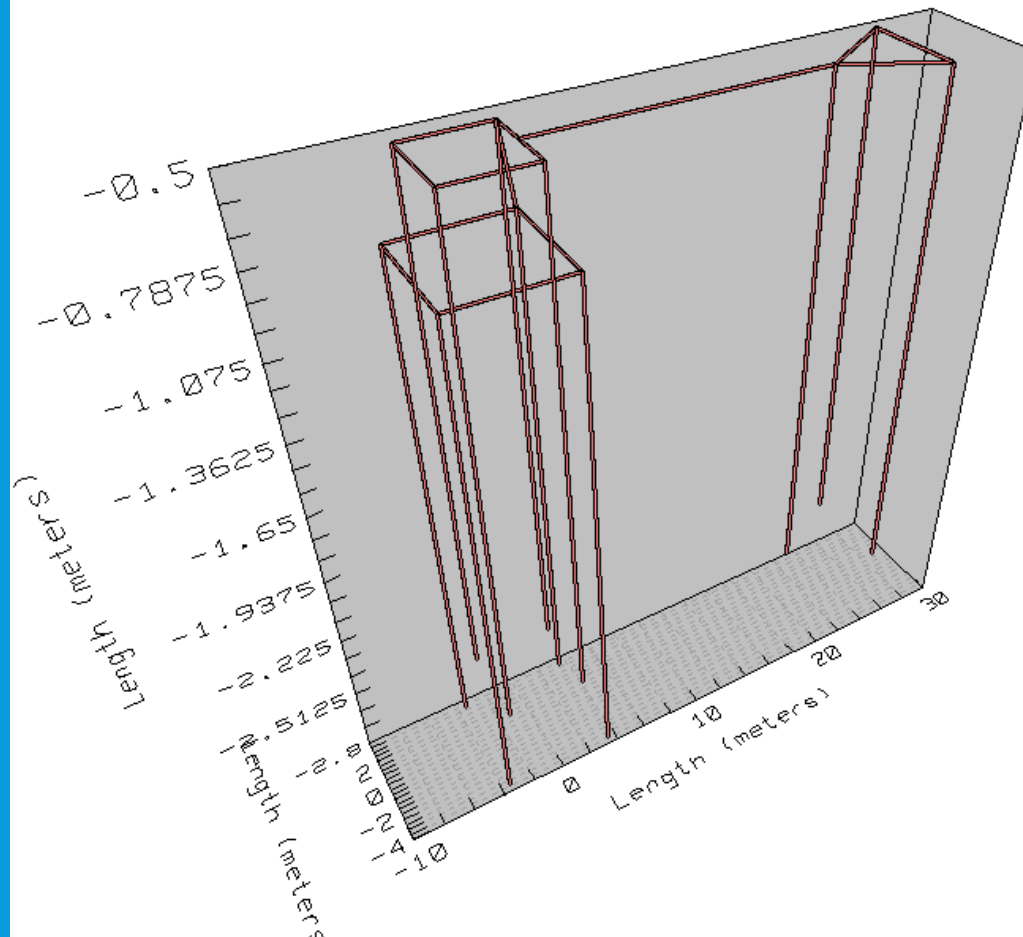
# Uzemljivač PTTs



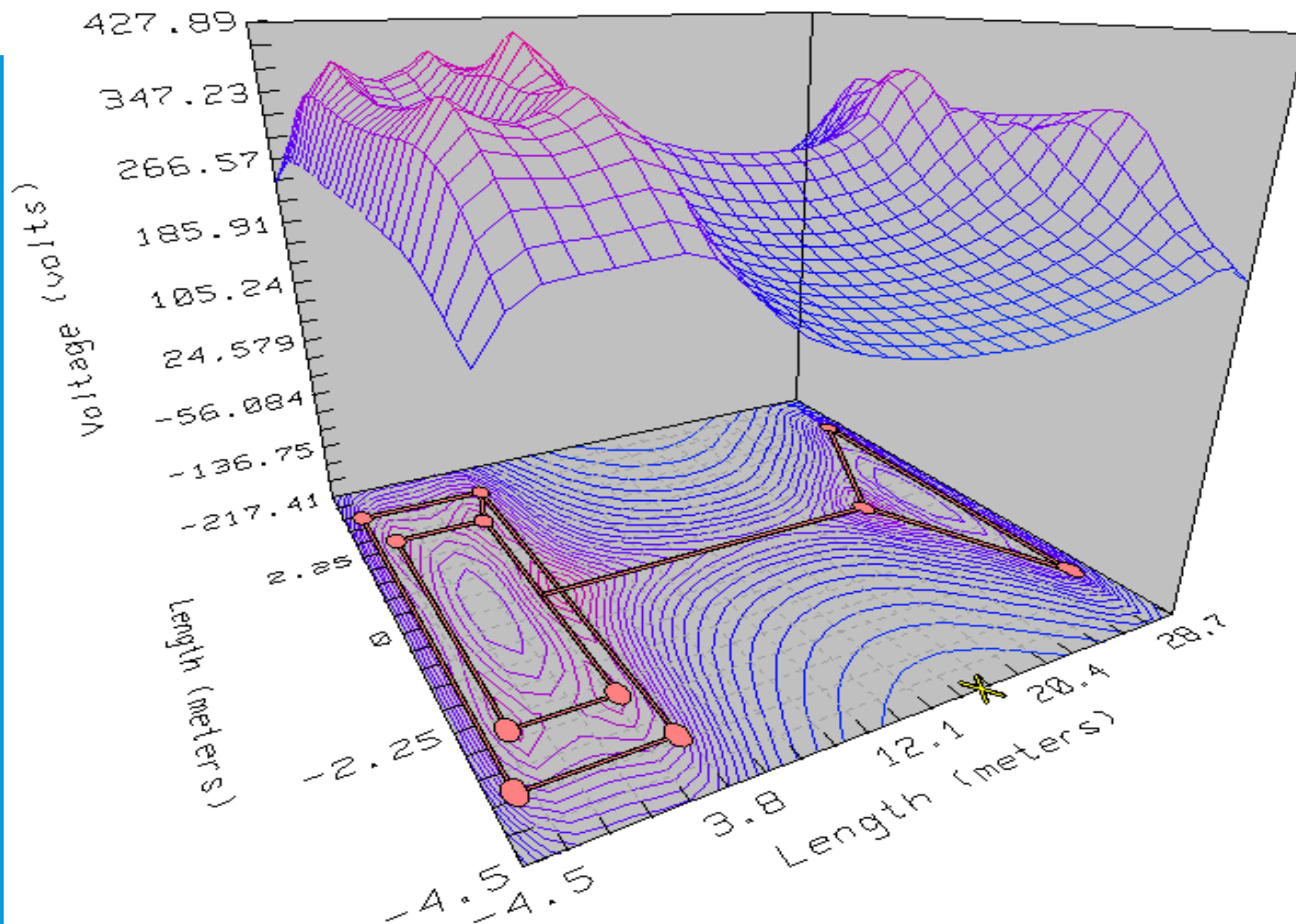
# Uzemljivač PTTS u programu CYMGRD (zaštitno i radno uzemljenje)



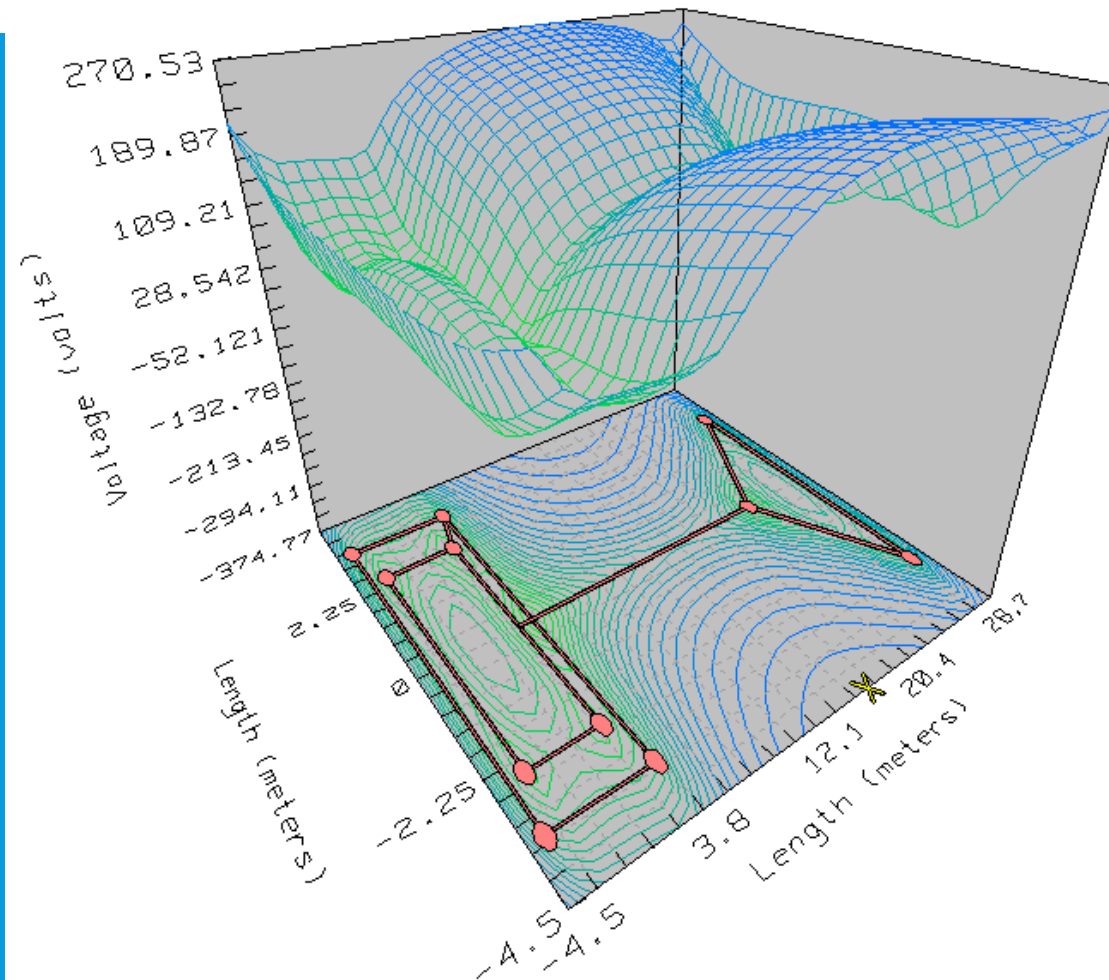
# Uzemljivač PTTs u programu CYMGRD (združeno uzemljenje)



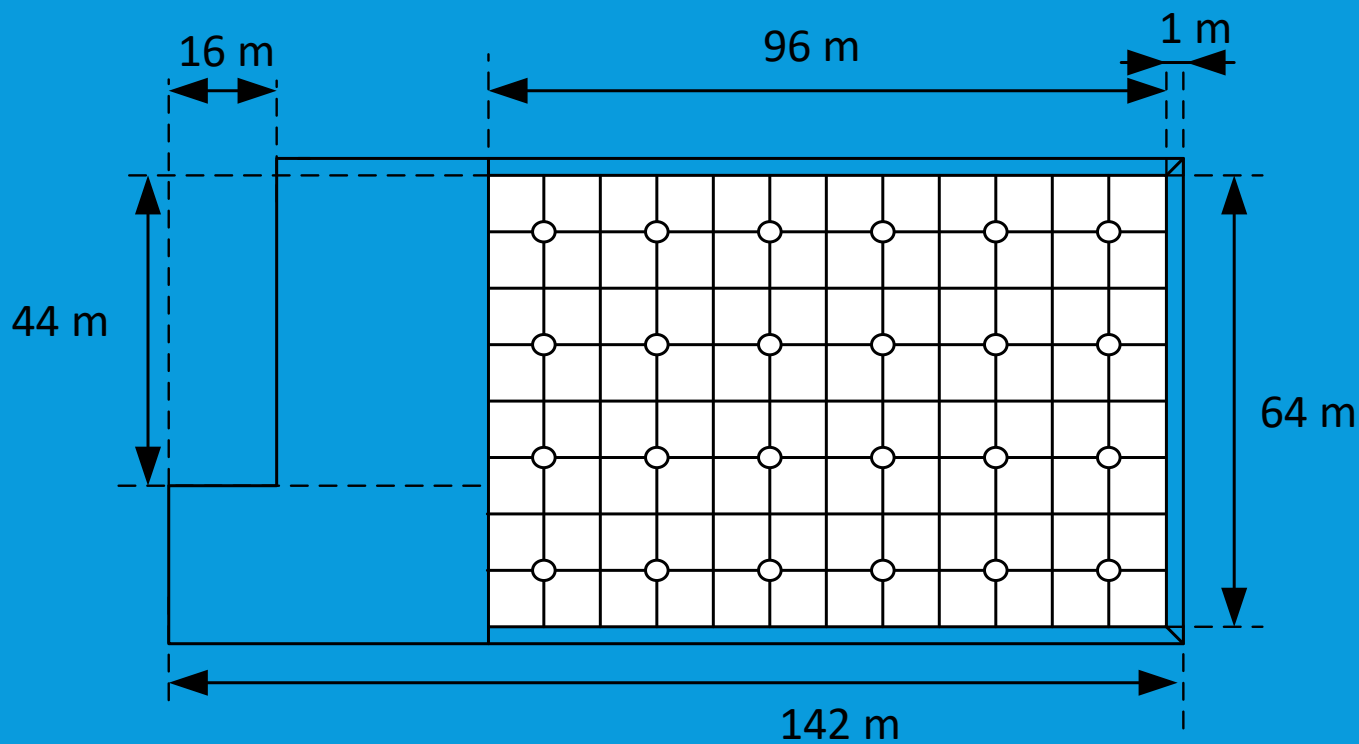
# Uzemljivač PTTs u programu CYMGRD (potencijal zemljišta)



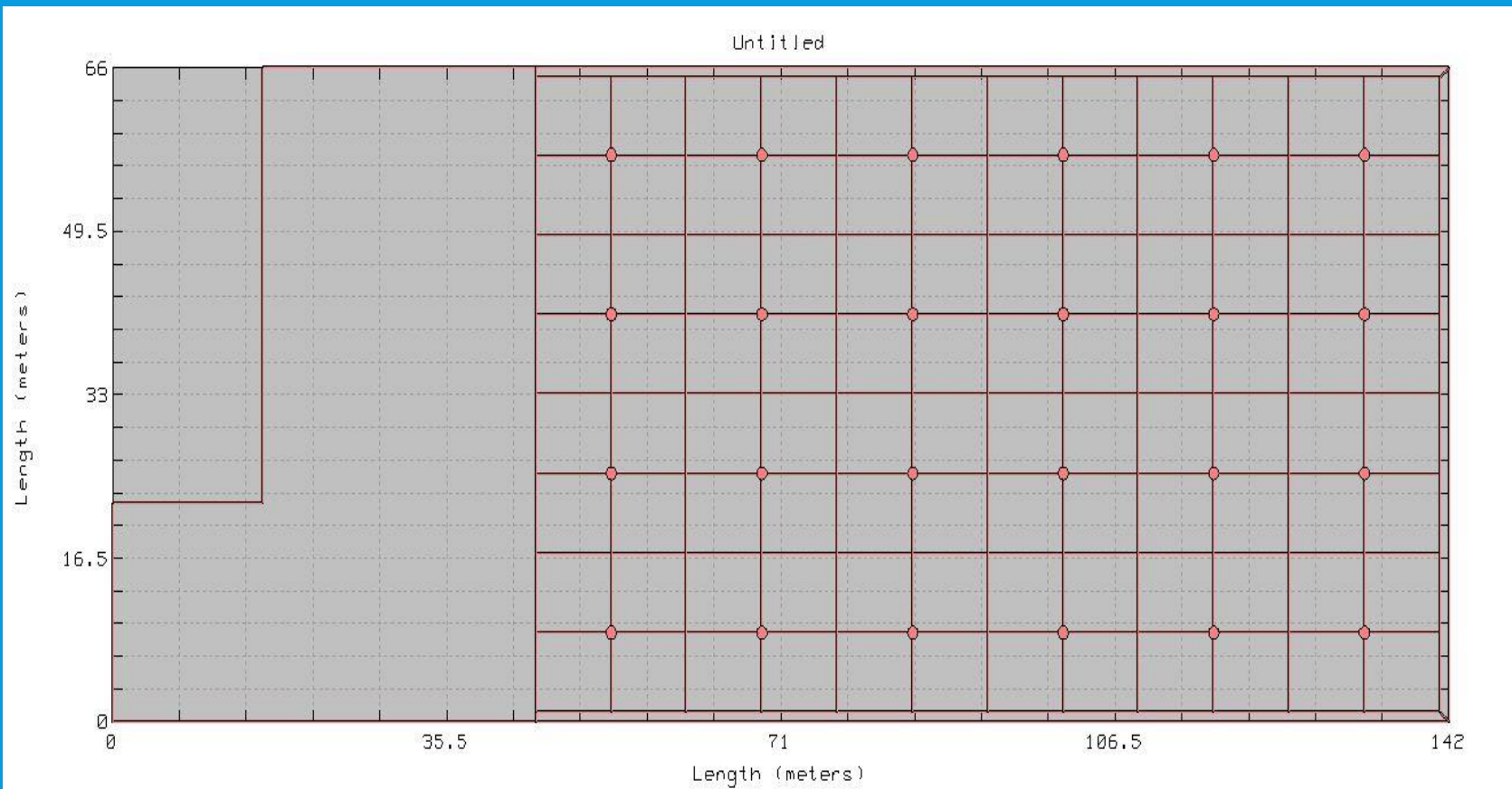
# Uzemljivač PTTs u programu CYMGRD (naponi dodira)



# *Uzemljivač VN trafostanice*

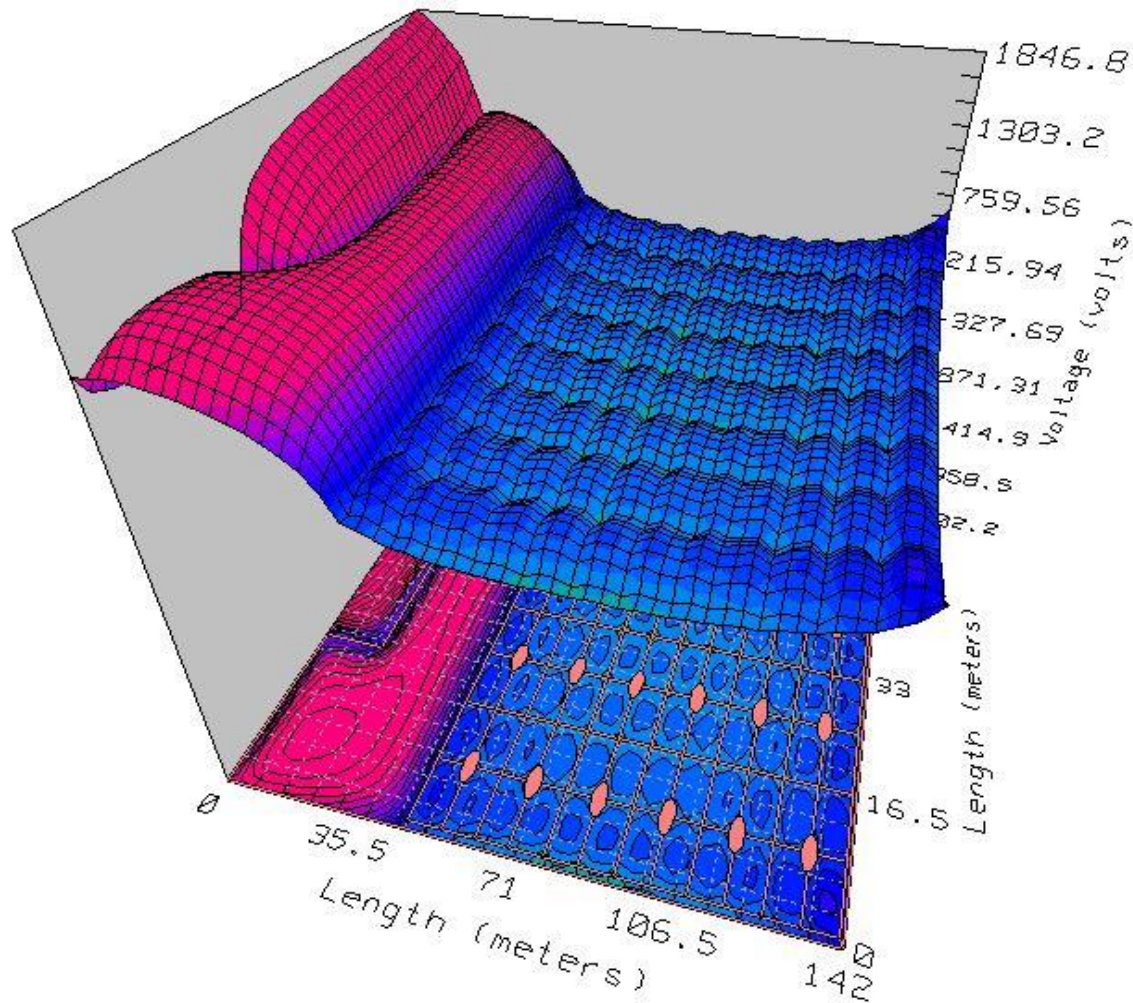


# *Uzemljivač VN trafostanice u CYMGRD-u*

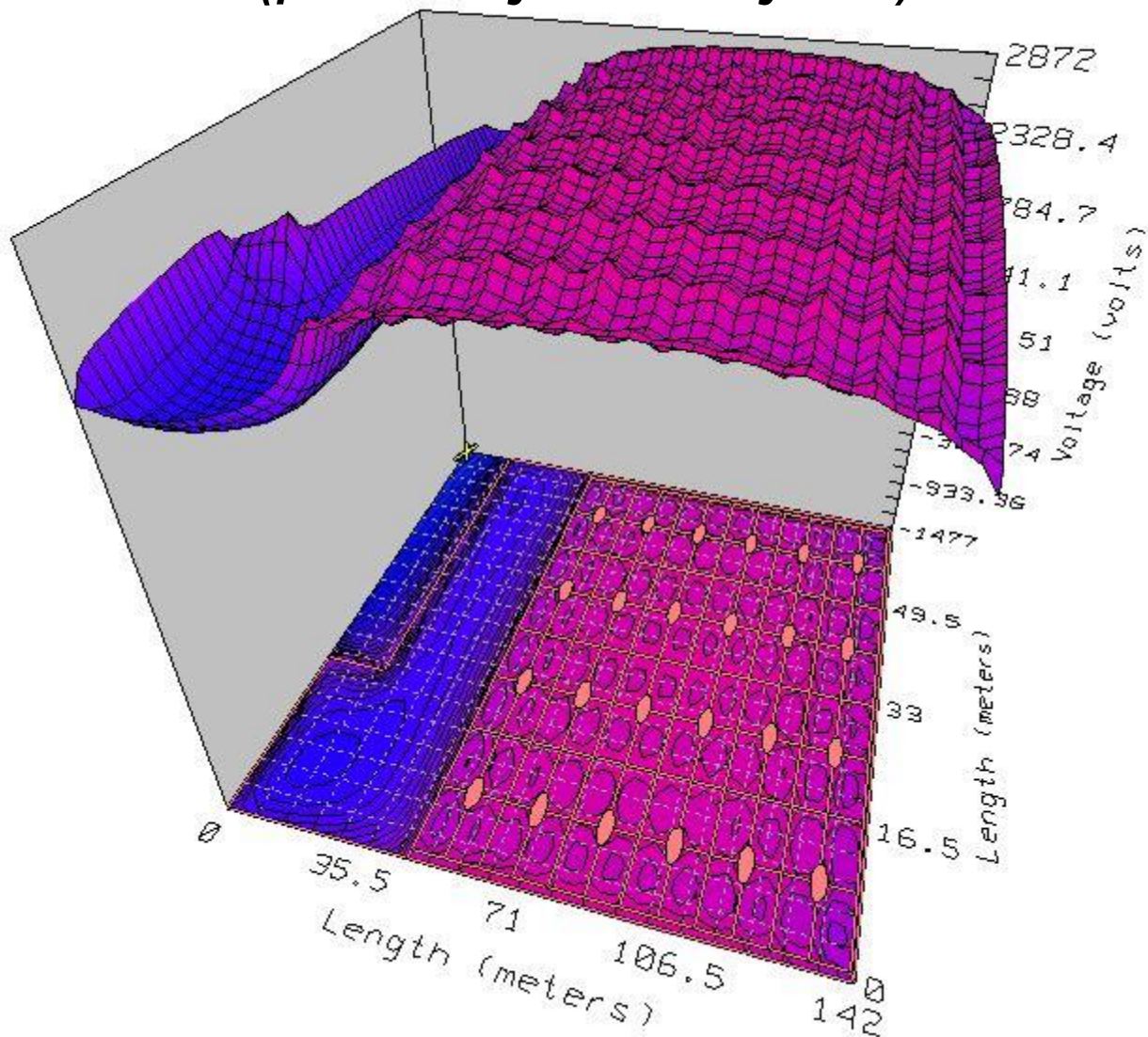




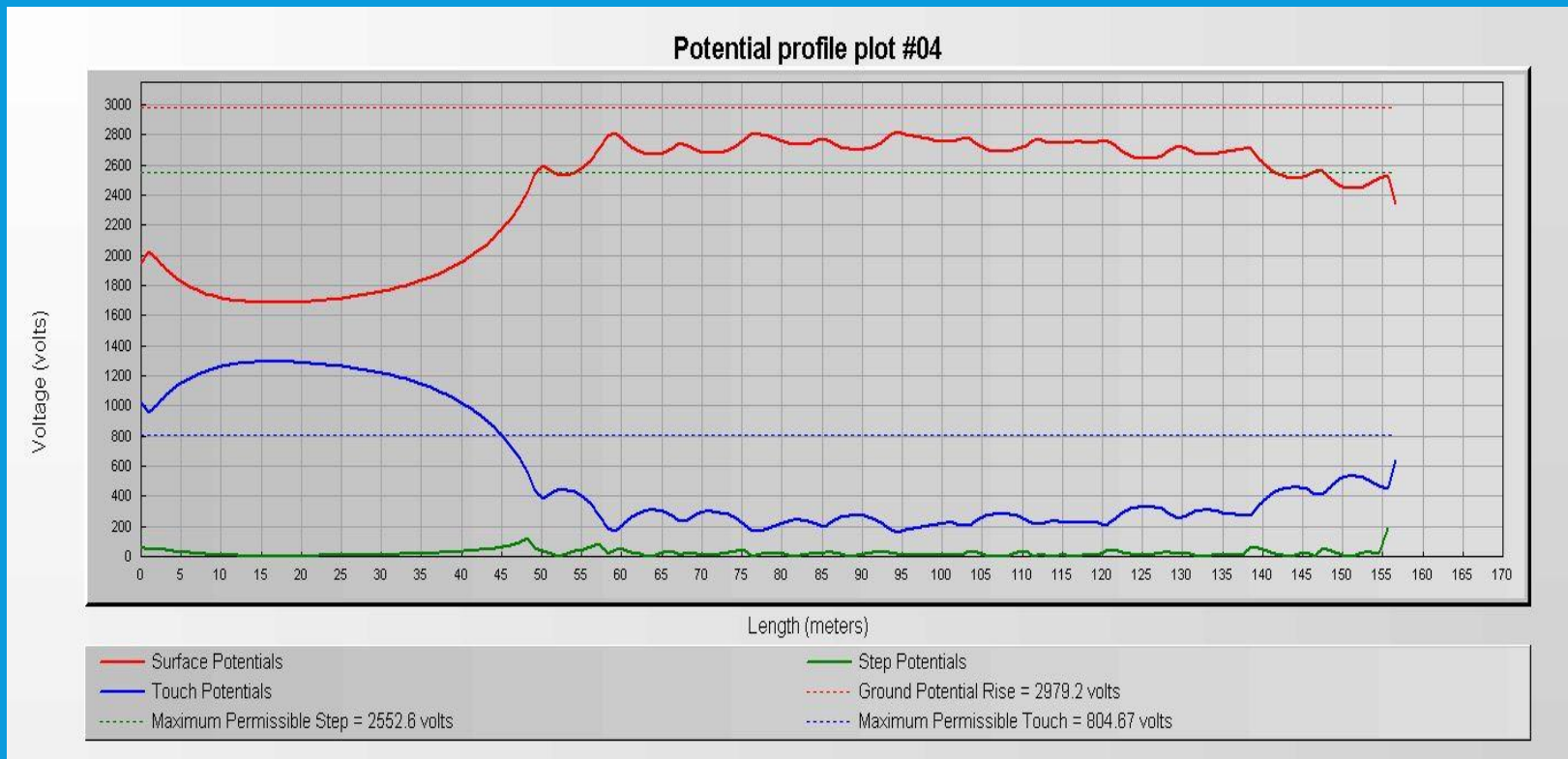
# Uzemljivač VN trafostanice u CYMGRD-u (naponi dodira)



# Uzemljivač VN trafostanice u CYMGRD-u (potencijal zemljišta)



# Uzemljivač VN trafostanice u CYMGRD-u (naponi dodira i koraka)



# *Instrument za mjerenje otpora uzemljenja i otpornosti tla*





# Mjerenje otpornosti tla









# Analiza uzemljivača u programu XGSLab

Calculation Time: 16:52:17    Coordinates: x: 376.41 [m]    y: 394.2 [m]    z: --

**LEGEND**

- Color Code System
- Soil Layers Interface
- Injection Point
- Reference Point
- Snap [m] 5
- Volume Visualization
  - x left [m] -46.00
  - y lower [m] -46.00
  - z height [m] 0.000
  - Length [m] 482.0
  - Width [m] 402.0
  - Height [m] 12.00
- Axes Orientation and Origin

View 2D  
View 3D

Type	Code	Text	Time	Count
Info	Generic.Open	Open Project EN Tutorial GSAFD	04:51:54	
Info	Generic.Open	Project created with an old XGSLab version! The project is updated to the current version.	04:51:52	

**XGSLab [EN Tutorial GSAFD]**

File Project Analysis Summary Libraries Windows Help

GSA GSA\_FD XGSA\_FD XGSA\_TD NETS

Project Information Reference Standard Sinusoidal Transient

Uniform Model Multilayer Model Multizone Model

Import and Export List Energization

Debug Compute Split Factor Conductor Sizing Catenary Corona Effect

Details

Soil: Ust\_Uss  SCL

Data: REFERENCE Mode: Arbitr... [v]

Limits: Value [V]: 0 [deg]: 0

Results: Safe Areas + View 2D

TSV: Style: Colors

TOUCH VOLTAGES: Maximum [V]: 1384.27 Minimum [V]: 295.96

Ut\_Ust + View 2D < > View 3D

STEP VOLTAGES: Maximum [V]: 30.96 Minimum [V]: 0.55

Us\_Uss + View 2D < > View 3D

MF Line Calculation MF LC Results MF Area Calculation AC 3D Magnetic Field TSV Area Calculation AC 3D Touch Voltages

LEGEND

Range [V]

296.0	373.7
373.7	451.4
451.4	529.2
529.2	606.9
606.9	684.6
684.6	762.4
762.4	840.1
840.1	917.9
917.9	995.6
995.6	1.073E3
1.073E3	1.151E3
1.151E3	1.229E3
1.229E3	1.307E3
1.307E3	1.384E3

Actual Range

Ut max [V] 1.384E3

Ut min [V] 308.4

Z calculation [m] 0

Plot Point Arbitr...

Calculation Time: - 16:54:50 Coordinates: x: ∞ [m] y: ∞ [m] z: --

Messages

Type	Code	Text	Time	Count
Info	Generic	Calculation successful!	04:55:13	1
Info	Generic	Calculation successful!	04:54:22	1
Info	Generic	Calculation successful!	04:53:46	1
Info	Generic.Open	Open Project EN Tutorial GSAFD	04:51:54	1
Info	Generic.Open	Project created with an old XGSLab version! The project is updated to the current version.	04:51:52	1



**XGSLab [EN Tutorial GSAFD]**

File Project Analysis Summary Libraries Windows Help

GPR and Earthing Impedance Additional Impedance Distributions

Line Calculation Area Calculation Line Calculation Area Calculation Line Calculation Area Calculation

Results Touch and Step Voltages Magnetic Field Electric Field

Details

Soil Data Limits Results TSV TSV MF MF EF

Calculate Load

Results

Maximum [ $\mu\text{T}$ ] 1500

Minimum [ $\mu\text{T}$ ] 0

Magnetic Flux [Wb] 4.714

Induced EMF [V] 1.481E3

Normal Only

Style Colors

Mod  Re x  Im x  
 Mod x  Re y  Im y  
 Mod y  Re z  Im z

View 2D View 3D Export Save

Safe Areas View

MF LC Results MF Area Calculation AC 3D Magnetic Field TSV Area Calculation AC 3D Touch Voltages AC 3D Magnetic Field

LEGEND

Plotted: Modulus

Range [ $\mu\text{T}$ ]

0.000	107.1
107.1	214.3
214.3	321.4
321.4	428.6
428.6	535.7
535.7	642.9
642.9	750.0
750.0	857.1
857.1	964.3
964.3	1.071E3
1.071E3	1.179E3
1.179E3	1.286E3
1.286E3	1.393E3
1.393E3	1.500E3

Actual Range

Maximum [ $\mu\text{T}$ ] 1.398E3

Minimum [ $\mu\text{T}$ ] 1.309

Z calculation [m] 0

Calculation Time: - 16:54:50 Coordinates: x:  $\infty$  [m] y:  $\infty$  [m] z: --

Messages

Type	Code	Text	Time	Count
Info	Generic	Calculation successful!	04:55:13	1
Info	Generic	Calculation successful!	04:54:22	1
Info	Generic	Calculation successful!	04:53:46	1
Info	Generic.Open	Open Project EN Tutorial GSAFD	04:51:54	1
Info	Generic.Open	Project created with an old XGSLab version! The project is updated to the current version.	04:51:52	1

Current Project: [EN Tutorial GSAFD] GSA\_FD EN 50522:2010 50.00 Hz Multilayer Results Scale = 1 Hint: Results Available

Ver. 9.2.1.1

# LITERATURA

- 1. Materijali s predavanja
- 2. F. Majdandžić, Uzemljivači i sustavi uzemljenja, Graphis, Zagreb, 2004.
- 3. H. Požar, Visokonaponska rasklopna postrojenja, Tehnička knjiga - Zagreb, 1967.