ELEKTRIJADA 2011 – Power System Analysis

Annotation: Answer the questions by encircling one of the given answers. Only ONE of the given answers in each problem is correct. Number of points for each correct answer is given in brackets. Incorrect answer is worth **-25%** of the points in brackets. The answer ''I don't know'' is worth 0 points. If You encircle more than one answer, it will be treated as incorrect. You should submitt these papers as well as papers on which calculations were carried out.

1. (5 points) The regulated transformer ratio is given:

$$m_T = \frac{110 \pm 10 \times 1{,}5\%}{36{,}75}\frac{\text{kV}}{\text{kV}}$$

If the position of the regulator is n=+3, the actual transformer ratio is:

a) m_T=3,128.
b) m_T=3.
c) m_T=1,045.
d) None of the above answers is correct.
e) I don't know.

2. (5 points) Find reactive power of a shunt capacitive compensation, in respect to apparent consumption power S_p ($\underline{S}_p=P_p+jQ_p$), in order to improve cosφ from 0,8 to 0,95:

a) $Q_c=0{,}4213S_p$.
b) $Q_c=0{,}562S_p$.
c) $Q_c=0{,}377S_p$.
d) None of the above answers is correct.
e) I don't know.

3. (8 points) Parameters of an overhead transmision line (220 kV, 50 Hz) are:

r_v=0,125 Ω/km; x_v=0,4 Ω/km;
$g_v=0{,}1\cdot10^{-6}$ S/km; $c_v=9\cdot10^{-9}$ F/km;
L_v=100 km.

Find the line phase constant:

a) $\beta = 1{,}288$ rad/km.
b) $\beta = 0{,}059\,°$/km.
c) $\beta = 1{,}0732\cdot10^{-3}$ rad/km.
d) None of the above answers is correct.
e) I don't know.

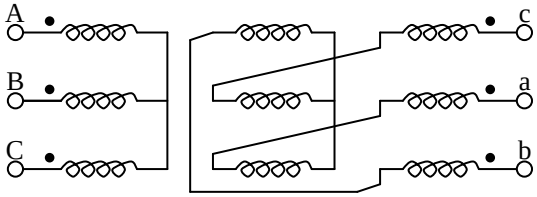
4. (8 points) Data on the transformer's plate are:

S_n=40 MVA; U_{n1}=110 kV; U_{n2}=36,75 kV;
u_{ks}=5 %; P_{Cun}=250 kW

The transformer's impedance calculated for primar voltage is:

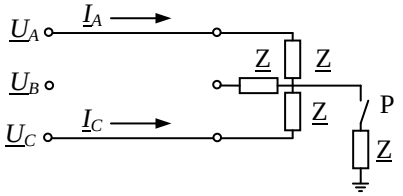
a) $\underline{Z}_T = (1{,}89 + j15{,}125)\,\Omega$
b) $\underline{Z}_T = (1{,}89 + j15{,}006)\,\Omega$.
c) $\underline{Z}_T = (0{,}756 + j15{,}125)\,\Omega$.
d) None of the above answers is correct.
e) I don't know.

5. (10 points) For the transformer shown in the figure below, find the phase group.



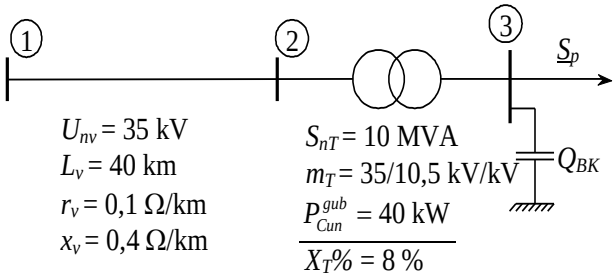
a) 3
b) 5
c) 11
d) None of the above answers is correct.
e) I don't know.

6. (10 points) Find the ratio of star point voltages (U_1/ U_2) in two cases:
1. the switch P is opened (U_1)
2. the switch P is closed (U_2)



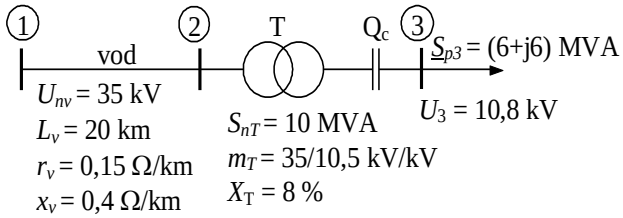
a) 2
b) 1
c) 1,5
d) None of the above answers is correct.
e) I don't know.

7. (12 points) In the power system, shown in the figure below, the bus 1 voltage is constant U_1 = 37 kV. Apparent consumption power on the bus 3 is $\underline{S}_p$ = (5 + *j*3) MVA. Find the voltage on the bus 3 if a shunt capacitor bank of nominal reactive power Q_{BK} = 2 Mvar (U_{nBK} = 10 kV) is connected (figure). Ignore the phase component of voltage drop.



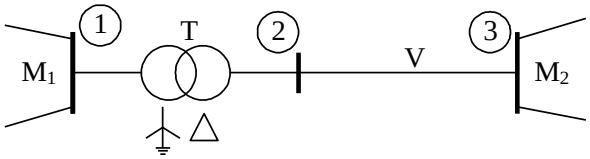
a) U_3=10,765 kV.
b) U_3=10,69 kV.
c) U_3=10,51 kV.
d) None of the above answers is correct.
e) I don't know.

8. (12 points) In the power system, shown in the figure below, the bus 1 voltage is constant U_1 = 36 kV. For the state shown in the figure below, find the power of the series capacitor bank.



a) Q_c=5,586 Mvar.
b) Q_c=0,989 Mvar.
c) Q_c=1,16 Mvar.
d) None of the above answers is correct.
e) I don't know.

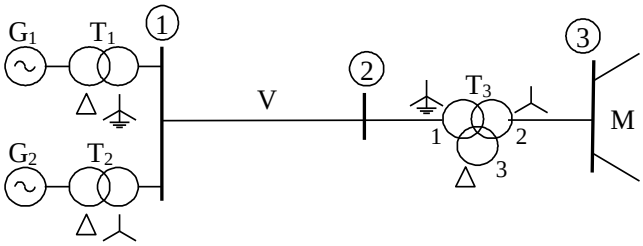
9. (15 points) In the power system shown in the figure below, a single phase to ground fault has occurred on the bus 2. The fault impedance is $\underline{Z}_f$=6 Ω. Find the fault current. The voltage on the bus 2 before the fault has occurred was $U_{f2}^{pk} = 220/\sqrt{3}$ kV.



M1: S_{3kz}=12000 MVA pri U_{M1}=400 kV
X_{iM1}= X_{dM1}; X_{oM1}= 2X_{dM1}
T: S_{nT}=300MVA; m_T=400/231 kV/kV; x_T=12 %
V: L_v=120 km; x_v=0,4 Ω/km; x_{ov} =3x_v;
M2: S_{3kz}=7500 MVA pri U_{M1}=210 kV
X_{iM1}= X_{dM1}; X_{oM1}= 2X_{dM1}.

a) $\underline{I}_k$=(0,0628-j1,997) kA.
b) $\underline{I}_k$=(0,187-j1,981) kA.
c) $\underline{I}_k$=(0,174-j1,909) kA.
d) None of the above answers is correct.
e) I don't know.

10. (15 points) In the power system shown in the figure below, a single phase to ground fault has occurred on the bus 2. Find the star point voltage of the transformer T_2 during the fault.
Note: The voltage on the bus 2 before the fault has occurred was 1 r.u..



G_1 i G_2: x_{G1}=x_{G1}=0.24 r.u.
T_1 i T_2: x_{T1}=x_{T2}=0.12 r.u.
T_3: x_{12}=0.06 r.u.; x_{13}=0.08 r.u.; x_{23}=0.04 r.u.
Vod: x_v=0.1 r.u.; x_{vo}=0.3 r.u.
M: system of "∞" power.

a) U_{zv}=0,234 r.u.
b) U_{zv}=0,363 r.u.
c) U_{zv}=0,35 r.u.
d) None of the above answers is correct.
e) I don't know.