WROCLAW UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF ELECTRICAL ENGINEERING

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Lab 3 -Load flow calculation in meshed network

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1.Objective

to determine load flow in meshed and visualize the effect of reactive power variation at bus 2 network.

2. Exercise description

Network configuration is to be determined as follows:

- breaker W1 is switched on,
- breaker W2 is switched off to isolate generator from the station R-2 110/10 kV,
- breaker W3 is switched off to isolate generator from the R-3 110/10 kV,

3.Procedure

the task is to analyze the bus voltages for the three scenarios shown below:

Pg, MW	Qg, Mvar
14.1	0
14.1	6
14.1	-6

4.Scheme of analyzed power system

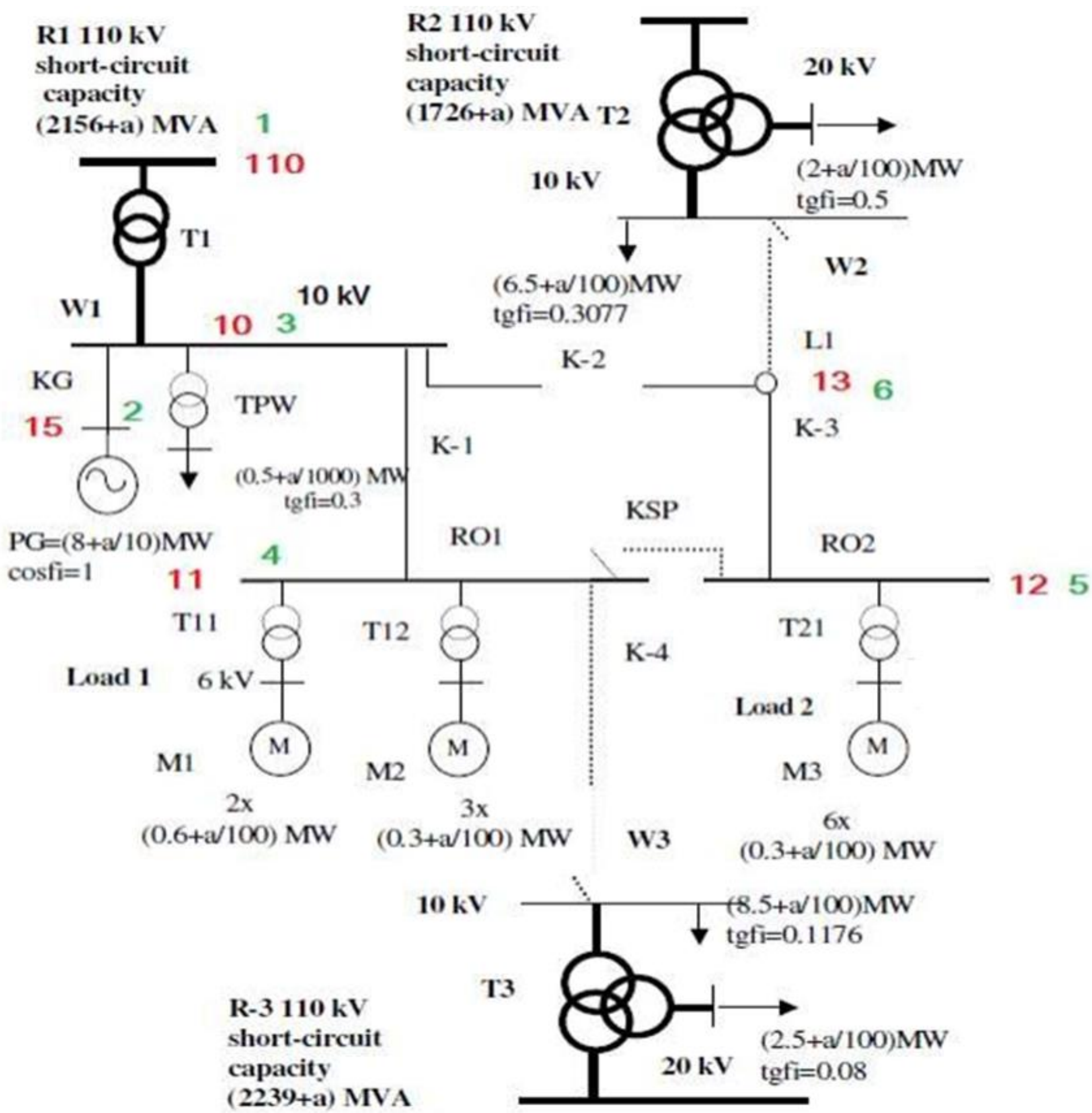

Figure 1: Scheme of analyzed meshed network

5. Code for calculating System parameters for a=61

```
% calculations of system parameter
a=61
```

```
Sb = 100;%MVA
Ub = 10;%kV
Zb= (Ub)^2/Sb
% calculation for Generator(PG)
PG=(8+a/10)%MW
% calculation for T1
% given parameter
SN_T1 = 40; %MVA
UNH_T1 = 115;%kv
UNL_T1 = 11; %kV
uk_T1 = (11+a/100);%percentage
Pcu_T1 = (205+a);%kW
PFe_T1 = (33+a/10);%kW
I0_T1 = (0.5+a/100);%percentage
%Parameters related to UNL_T1 = 11 kV
R_T1=(((Pcu_T1*1e3)/(SN_T1*1e6))*(((UNL_T1)*1e3)^2/(SN_T1*1e6)))/Zb;%pu
X_T1=((uk_T1/100)*(((UNL_T1)*1e3)^2/(SN_T1*1e6)))/Zb;%pu
G_T1= (PFe_T1*1e3)/(((UNL_T1)*1e3)^2);%pu
B_T1= (I0_T1/100)*((SN_T1*1e6)/((UNL_T1)*1e3)^2);%pu
%Transformer 21(T21) parameter result
R_transformer1=[R_T1 X_T1 G_T1 B_T1];
R_t1 = {'R_T1(pu)', 'X_T1(pu)','G_T1(pu)','B_T1(pu)'};
T1_Table =
table(R_transformer1(:,1),R_transformer1(:,2),R_transformer1(:,3),R_transformer1(:,4)
,'VariableNames',R_t1)
% calculation for T21
%Transformer T21 calculations(two transformers connected in parallel)
%given parameters
S_N = 3000; %kVA
u_k = (6+a/100); %percentage
U_NH = 10.5; %kV
U_NL = 0.525; %kV
P_Fe = (2.1+a/100); %kW
P_Cu = (11+a/100); %kW
I0 = (1+a/100); %percentage
%transformer T21 calculations
u_R = (P_Cu/S_N)*100; %percentage
u_x = sqrt(u_k^2 - u_R^2); %percentage
R_T21 = ((u_R/100)*(U_NH^2/(S_N/1000)))/2; %pu, divided by 2 for parallel transformer
X_T21 = ((u_x/100)*(U_NH^2/(S_N/1000)))/2; %pu, divided by 2 for parallel transformer
G_T21 = (P_Fe/((U_NH^2)*1e3))*2; % pu,multiplied by 2 for parallel transformer
B_T21 = ((I0/100)*((S_N)/((U_NH^2)*1e3)))*2; %pu,multiplied by 2 for
paralleltransformer
%Transformer 21(T21) parameter result
R_transformer21=[R_T21 X_T21 G_T21 B_T21];
R_t21 = {'R_T21(pu)', 'X_T21(pu)','G_T21(pu)','B_T21(pu)'};
T21_Table =
table(R_transformer21(:,1),R_transformer21(:,2),R_transformer21(:,3),R_transformer21(
:,4),'VariableNames',R_t21)
% calculation for T11
% given parameter
SN_T11 = 2000; %KVA
UNH_T11 = 10;%kv
UNL_T11 = 6; %kV
uk_T11 = (6+a/100);%percentage
```

```
Pcu_T11 = (17+a/100);%kW
PFe_T11 = (3.1+a/100);%kW
I0_T11 = (1.2+a/100);%percentage
%Parameters related to UNL_T11 = 6 kV
R_T11=(((Pcu_T11*1e3)/(SN_T11*1e3))*((UNL_T11*1e3)^2/(SN_T11*1e3)))/Zb;%pu
X_T11=((uk_T11/100)*((UNL_T11*1e3)^2/(SN_T11*1e3)))/Zb;%pu
G_T11= (PFe_T11*1e3)/((UNL_T11*1e3)^2);%pu
B_T11= (I0_T11/100)*((SN_T11*1e3)/(UNL_T11*1e3)^2);%pu
%Transformer 11(T11) parameter result
R_transformer11=[R_T11 X_T11 G_T11 B_T11];
R_t11 = {'R_T11(pu)', 'X_T11(pu)','G_T11(pu)','B_T11(pu)'};
T11_Table =
table(R_transformer11(:,1),R_transformer11(:,2),R_transformer11(:,3),R_transformer11(
:,4),'VariableNames',R_t11)
% calculation for T12
% given parameter
SN_T12 = 1000; %KVA
UNH_T12 =10.5;%kv
UNL_T12 = 525; %V
uk_T12 = (6+a/100);%percentage
Pcu_T12= (11+a/100);%kW
PFe_T12 = (2.1+a/100);%kW
I0_T12 = (1.0+a/100);%percentage
%Parameters related to UNL_T12 = 525V
R_T12=(((Pcu_T12*1e3)/(SN_T12*1e3))*((UNL_T12)^2/(SN_T12*1e3)))/Zb;%pu
X_T12=((uk_T12/100)*((UNL_T12)^2/(SN_T12*1e3)))/Zb;%pu
G_T12= (PFe_T12*1e3)/((UNL_T12)^2);%pu
B_T12= (I0_T12/100)*((SN_T12*1e3)/(UNL_T12)^2);%pu
%Transformer 12(T12) parameter result
R_transformer12=[R_T12 X_T12 G_T12 B_T12];
R_t12 = {'R_T12(pu)', 'X_T12(pu)','G_T12(pu)','B_T12(pu)'};
T12_Table =
table(R_transformer12(:,1),R_transformer12(:,2),R_transformer12(:,3),R_transformer12(
:,4),'VariableNames',R_t12)
% calculation for TPW
% given parameter
SN_TPW = 630; %KVA
UNH_TPW = 10.5;%kv
UNL_TPW = 400; %V
uk_TPW = (6+a/100);%percentage
Pcu_TPW = (6.6+a/100);%kW
PFe_TPW = (1.47+a/100);%kW
I0_TPW = (1.6+a/100);%percentage
%Parameters related to UNL_TPW = 400 V
R_TPW=(((Pcu_TPW*1e3)/(SN_TPW*1e3))*((UNL_TPW)^2/(SN_TPW*1e3)))/Zb;%pu
X_TPW=((uk_TPW/100)*((UNL_TPW)^2/(SN_TPW*1e3)))/Zb;%pu
G_TPW= (PFe_TPW*1e3)/((UNL_TPW)^2);%pu
B_TPW= (I0_TPW/100)*((SN_TPW*1e3)/(UNL_TPW)^2);%pu
%Transformer TPW(TPW) parameter result
R_transformerTPW=[R_TPW X_TPW G_TPW B_TPW];
R_tpw = {'R_TPW(pu)', 'X_TPW(pu)','G_TPW(pu)','B_TPW(pu)'};
TPW_Table =
table(R_transformerTPW(:,1),R_transformerTPW(:,2),R_transformerTPW(:,3),R_transformer
TPW(:,4),'VariableNames',R_tpw)
% line cable parameter
```

```
% Al_Cable_3x240_mm^2 per km parameters
R_Al_Cable_3x240_mm_squire=0.128;%ohm/km
X_Al_Cable_3x240_mm_squire=0.080;%ohm/km
S_Al_Cable_3x240_mm_squire=95;%MikroS/km
%cable length for K-1,K-2,k-3,KSP and KG
L_K_1=(0.485+a/10);%km
L_K_2=(1.7+a/10);% km
L_K_3=(2.13+a/10);% km
L_KSP=(0.3+a/100);%km
L_KG=(0.05+a/10);%km
% parameter calculation for cable 1...k-1
R_k_1=L_K_1*R_Al_Cable_3x240_mm_squire;%pu
X_k_1=L_K_1*X_Al_Cable_3x240_mm_squire;%pu
S_k_1=L_K_1*S_Al_Cable_3x240_mm_squire *1e-6;%pu
%cable1 parameter result
R_cable1=[R_k_1 X_k_1 0 S_k_1];
r_cable1 = {'R_k1(pu)', 'X_k1(pu)','G_k1(pu)','B_k1(pu)'};
cable1_Table =
table(R_cable1(:,1),R_cable1(:,2),R_cable1(:,3),R_cable1(:,4),'VariableNames',r_cable
1)
%parameter calculation for cable 2...k-2
R_k_2=L_K_2*R_Al_Cable_3x240_mm_squire;%pu
X_k_2=L_K_2*X_Al_Cable_3x240_mm_squire;%pu
S_k_2=L_K_2*S_Al_Cable_3x240_mm_squire *1e-6;%pu
%cable2 parameter result
R_cable2=[R_k_2 X_k_2 0 S_k_2];
r_cable2 = {'R_k2(pu)', 'X_k2(pu)','G_k2(pu)','B_k2(pu)'};
cable2_Table
=table(R_cable2(:,1),R_cable2(:,2),R_cable2(:,3),R_cable2(:,4),'VariableNames',r_cabl
e2)
%parameter calculation for cable-3....K_3
R_k_3=L_K_3*R_Al_Cable_3x240_mm_squire;%pu
X_k_3=L_K_3*X_Al_Cable_3x240_mm_squire;%pu
S_k_3=L_K_3*S_Al_Cable_3x240_mm_squire *1e-6;%pu
%cable3 parameter result
R_cable3=[R_k_3 X_k_3 0 S_k_3];
r_cable3 = {'R_k3(pu)', 'X_k3(pu)','G_k3(pu)','B_k3(pu)'};
cable3_Table =
table(R_cable3(:,1),R_cable3(:,2),R_cable3(:,3),R_cable3(:,4),'VariableNames',r_cable
3)
%parameter calculation for cable KSP...kSP
R_KSP=L_KSP*R_Al_Cable_3x240_mm_squire;%pu
X_KSP=L_KSP*X_Al_Cable_3x240_mm_squire;%pu
S_KSP=L_KSP*S_Al_Cable_3x240_mm_squire *1e-6;%pu
%cable KSP parameter result
R_cableKSP=[R_KSP X_KSP 0 S_KSP];
r_cableKSP = {'R_KSP(pu)', 'X_KSP(pu)','G_KSP(pu)','B_KSP(pu)'};
cableKSP_Table =
table(R_cableKSP(:,1),R_cableKSP(:,2),R_cableKSP(:,3),R_cableKSP(:,4),'VariableNames'
,r_cableKSP)
% parameter calculation for cable KG...KG
R_KG=L_KG*R_Al_Cable_3x240_mm_squire;%pu
X_KG=L_KG*X_Al_Cable_3x240_mm_squire;%pu
S_KG=L_KG*S_Al_Cable_3x240_mm_squire *1e-6;%pu
%cableKG parameter result
```

```
R_cableKG=[R_KG X_KG 0 S_KG];
r_cableKG = {'R_KG(pu)', 'X_KG(pu)','G_KG(pu)','B_KG(pu)'};
cableKG_Table =
table(R_cableKG(:,1),R_cableKG(:,2),R_cableKG(:,3),R_cableKG(:,4),'VariableNames',r_c
ableKG)
% load parameter calculation
%LOAD at Bus 3
PLoad_bus3=(0.5+a/1000)/Sb;%pu
tgfi_bus3=0.3;
QLoad_bus3=(PLoad_bus3*tgfi_bus3);%pu
%Results of load  bus 3
R_load_bus3=[PLoad_bus3 QLoad_bus3];
R_load_bus = {'PLoad_bus3(pu)', 'QLoad_bus3(pu)'};
load_bus3_Table = table(R_load_bus3(:,1),R_load_bus3(:,2),'VariableNames',R_load_bus)
% induction moter 1(IM-1)
%2 induction motors - 2 pairs of poles i.e. p=2
PNM1= 2*(0.6+a/1000);%MW, two motors
UNM1=6; %kV
cos_phin1=(0.86+a/1000);
Eff_n1=0.97;
kLR = (4+a/100);
Pn_M1=(PNM1/Eff_n1)/Sb; %pu
SN_M1=Pn_M1/cos_phin1;
phi1=acosd(cos_phin1);
phi_m1=phi1*pi/180;
tg1=tan(phi_m1);
Qn_M1=(Pn_M1*tg1);%pu
%induction motor 1(IM1) parameter result
R_IM1_load=[Pn_M1 Qn_M1];
R_IM1 = {'Pd_M1(pu)', 'Qd_M1(pu)'};
IM1Load_Table = table(R_IM1_load(:,1),R_IM1_load(:,2),'VariableNames',R_IM1);
% induction moter 2(IM-2)
%3 induction motors - 1 pair of poles, i.e p=1
PNM2=3*(0.3+a/1000);%MW, three motors
UNM2=0.5;%kV
cos_phin2=(0.83+a/1000);
Eff_n2=0.94;
kLR =(5+a/100);
Pn_M2=(PNM2/Eff_n2)/Sb;%pu
SN_M2=Pn_M2/cos_phin2;
phi2=acosd(cos_phin2);
phi_M2=phi2*pi/180;
tg2=tan(phi_M2);
Qn_M2=(Pn_M2*tg2);%pu
%induction motor 2(IM2) parameter result
R_IM2_load=[Pn_M2 Qn_M2];
R_IM2 = {'Pd_M2(pu)', 'Qd_M2(pu)'};
IM2Load_Table = table(R_IM2_load(:,1),R_IM2_load(:,2),'VariableNames',R_IM2);
%bus 4 Load
w=Pn_M1+Pn_M2;
da=Qn_M1+Qn_M2;
R_load_bus4=[w da];
R_load_bus = {'Pload_bus4(pu)', 'Qload_bus4(pu)'};
load_bus4_Table = table(R_load_bus4(:,1),R_load_bus4(:,2),'VariableNames',R_load_bus)
% induction moter 3(IM-3)
```

```
%6 induction motors – 1 pair of poles, i.e p=1
%6 induction motors
P_NM=(0.3+a/100);% in MW
U_NM=0.5;%IN KV
K_LR=(7+a/100);
cos_fin=(0.83+a/1000);
cos_fik=(0.3+a/1000);
effi_n=0.94;
effi_M=0.97;%efficiency of motor
%calculations
% for 1 motor normaly loaded
P_N=P_NM/effi_M;
S_N=P_N/cos_fin;
fin=acosd(cos_fin);
Q_N=P_N*tan(fin);
% for 1 motor during start
sin_fik=sqrt(1-(cos_fik)^2);
P_K=K_LR*S_N*cos_fik;
Q_K=K_LR*S_N*sin_fik;
%for 3 motor normaly loaded and 3 motor during start
Pd_MW= (0*P_N + 6*P_K)/Sb;%pu
Qd_Mvar=(0*Q_N + 6*Q_K)/Sb;%pu
%induction motor 3(IM3) parameter result
R_IM3_load=[Pd_MW Qd_Mvar];
R_IM3 = {'Pd_M3(pu)', 'Qd_M3(pu)'};
IM3Load_Table = table(R_IM3_load(:,1),R_IM3_load(:,2),'VariableNames',R_IM3)
```

6. Result of system parameters

```
a = 61


Zb = 1


PG = 14.1000


T1_Table =

  1×4 table

    R_T1(pu)    X_T1(pu)     G_T1(pu)      B_T1(pu)
    ________    ________    __________    _________

    0.020116     0.3512     0.00032314    0.0036694


T21_Table =

  1×4 table
```

R_T21(pu)	X_T21(pu)	G_T21(pu)	B_T21(pu)
0.071111	1.2125	4.9161e-05	0.00087619

T11_Table =

1×4 table

R_T11(pu)	X_T11(pu)	G_T11(pu)	B_T11(pu)
0.15849	1.1898	0.00010306	0.0010056

T12_Table =

1×4 table

R_T12(pu)	X_T12(pu)	G_T12(pu)	B_T12(pu)
0.0032	0.018219	0.0098322	0.058413

TPW_Table =

1×4 table

R_TPW(pu)	X_TPW(pu)	G_TPW(pu)	B_TPW(pu)
0.0029065	0.016787	0.013	0.087019

cable1_Table =

1×4 table

R_k1(pu)	X_k1(pu)	G_k1(pu)	B_k1(pu)
0.84288	0.5268	0	0.00062558

cable2_Table =

1×4 table

R_k2(pu)	X_k2(pu)	G_k2(pu)	B_k2(pu)
0.9984	0.624	0	0.000741

cable3_Table =

1×4 table

R_k3(pu)	X_k3(pu)	G_k3(pu)	B_k3(pu)
1.0534	0.6584	0	0.00078185

cableKSP_Table =

1×4 table

R_KSP(pu)	X_KSP(pu)	G_KSP(pu)	B_KSP(pu)
0.11648	0.0728	0	8.645e-05

cableKG_Table =

1×4 table

R_KG(pu)	X_KG(pu)	G_KG(pu)	B_KG(pu)
0.7872	0.492	0	0.00058425

load_bus3_Table =

1×2 table

PLoad_bus3(pu)	QLoad_bus3(pu)
0.00561	0.001683

load_bus4_Table =

1×2 table

```
    Pload_bus4(pu)    Qload_bus4(pu)
    ______________    ______________

       0.02515           0.011635
```

```
IM3Load_Table =

  1×2 table

    Pd_M3(pu)    Qd_M3(pu)
    _________    _________

     0.17355      0.44834
```

7. Input data file

It is worth mentioning that this input data is the same for all the three scenarios except that the reactive power at bus 2 must be varied between 0, 6 and -6 Mvar while keeping the active power constant at 14.1MW.

```
%bus     name type Un_kV    Um      Uk_st      Pd        Qd       Pg        Qg       Psh      Qsh
%  1        2   3     4      5        6         7         8        9        10       11       12
   1      110   3 110.00 1.00000    0.0   0.00000   0.00000  0.00000   0.00000   0.0000   0.0000
   2       15   1  10.00 1.00000    0.0   0.00000   0.00000  0.141        0      0.0000   0.0000
   3       10   1  10.00 1.00000    0.0   0.00561   0.001683 0.00000   0.00000   0.0000   0.0000
   4       11   1  10.00 1.00000    0.0   0.02515   0.011635 0.00000   0.00000   0.0000   0.0000
   5       12   1  10.00 1.00000    0.0   0.17355   0.44834  0.00000   0.00000   0.0000   0.0000
   6       13   1  10.00 1.00000    0.0   0.00000   0.00000  0.00000   0.00000   0.0000   0.0000
 ];
% name_from name_t No_from N0_to    R       X       G          B         Smax    tm     tk_st  tmin    tmax    dtr      st
%   1        2      3      4        5       6       7          8          9      10      11     12      13      14      15
    110      10     1      3    0.020116 0.3512 0.0003231 -0.0036694 0.40000 1.00    0.0  0.79804 1.10200 0.012660  1
     10      11     3      4    0.84288  0.5268     0     0.00062558 0.05000 0.000   0.0  0.00000 0.00000 0.0       1
     11      12     4      5    0.11648  0.0728     0     8.645e-05  0.05000 0.000   0.0  0.00000 0.00000 0.0       0
     13      10     6      3    0.9984   0.624      0     0.000741   0.05000 0.000   0.0  0.00000 0.00000 0.0       1
     13      12     6      5    1.0534   0.6584     0     0.00078185 0.05000 0.000   0.0  0.00000 0.00000 0.0       1
     15      10     2      3    0.7872   0.492      0     0.00058425 0.12000 0.000   0.0  0.00000 0.00000 0.0       1

];
```

8. output Results

8.1. Results of the first scenario (Pg= 14.1 MW and Qg=0 Mvar)

```
>> esrm

plikdat =

    'esrmdat61'

 ITERACJA =1  signdetJ = -1    normaNZB=     0.14100000
 ITERACJA =2  signdetJ = -1    normaNZB=     0.01717676
 ITERACJA =3  signdetJ = -1    normaNZB=     0.00253079
 ITERACJA =4  signdetJ = -1    normaNZB=     0.00016334
 ITERACJA =5  signdetJ = -1    normaNZB=     0.00000082

 Brak wezlow TYP=5

=============================================================================
===
Time after the solution of nodal equations: 0.02 secs

===============================================================
        typ    Um  Uk_st Un_kV  Pg(MW) Qg(MVAR) Pd(MW) Qd(MVAR)
    ----   -------------------  --------------- ---------------
===============================================================
     110  3 1.0000   0.0 110.00   -0.46   11.06     -       -
      15  1 1.0642   4.1  10.00   14.10   -0.00     -       -
      10  1 0.9619   0.2  10.00    0.00    0.00    0.56    0.17
      11  1 0.9328  -0.0  10.00    0.00    0.00    2.51    1.16
      12  1 0.6614   5.0  10.00    0.00    0.00    5.73    6.19
      13  1 0.8152   2.1  10.00    0.00   -0.00     -       -
                                 -----   -----   -----   -----
                         SUM:    13.64   11.06    8.81    7.52

=============================================================================
==============
    FROM        To     FLOW at begin          FLOW at end       SMAX     BRANCH
losses
     BUS      BUS   P(MW)  Q(MVAR)   pSF   P(MW)  Q(MVAR)   pST     MVA    dP(MW)
dQ(MVAR)
-------- --------  --------------------   ---------------------  ------  ----
-------------
=============================================================================
==============
     110        10     -0.46     11.06   0.00     0.52   -10.29   0.00     40.00
0.055   0.769
```

```
      10         11      2.59      1.15   0.00    -2.52     -1.16   0.00      5.00
0.074  -0.010
 BRANCH is switched off
      11         12      0.00      0.00   0.00     0.00      0.00   0.00      5.00
0.000   0.000
      13         10     -7.44     -7.22   0.00     9.05      8.16   0.00      5.00
1.610   0.947
      13         12      7.44      7.22   0.00    -5.73     -6.19   0.00      5.00
1.710   1.026
      15         10     14.10     -0.00   0.00   -12.72      0.80   0.00     12.00
1.382   0.804

                                                                               ---
------  ---------
                                            TOTAL LOSSES    :    4.830   3.536

Time at the end of load flow computations: 0.02 secs
```

8.2. Results for the Second strategy (Pg= 14.1 MW and Qg=6 Mvar)

```
>> esrm


plikdat =

    'esrmdat61'

 ITERACJA =1  signdetJ = -1    normaNZB=     0.14100000

 ITERACJA =2  signdetJ = -1    normaNZB=     0.01681093

 ITERACJA =3  signdetJ = -1    normaNZB=     0.00192322

 ITERACJA =4  signdetJ = -1    normaNZB=     0.00007782

 ITERACJA =5  signdetJ = -1    normaNZB=     0.00000014


 Brak wezlow TYP=5


=============================================================================
===

Time after the solution of nodal equations: 0.02 secs


===============================================================

        typ    Um   Uk_st Un_kV  Pg(MW) Qg(MVAR) Pd(MW) Qd(MVAR)
```

```
    ----   ------------------  -------------- --------------
================================================================
     110  3 1.0000   0.0 110.00   -0.74    4.54     -       -
      15  1 1.1113   1.4  10.00   14.10    6.00     -       -
      10  1 0.9849   0.2  10.00    0.00   -0.00    0.56    0.17
      11  1 0.9564  -0.0  10.00    0.00    0.00    2.51    1.16
      12  1 0.7021   4.6  10.00    0.00    0.00    5.73    6.19
      13  1 0.8469   1.9  10.00    0.00   -0.00     -       -
                                  -----   -----   -----   -----
                          SUM:    13.36   10.54    8.81    7.52

==============================================================================
==============
    FROM       To    FLOW at begin         FLOW at end      SMAX    BRANCH
losses
     BUS      BUS   P(MW)  Q(MVAR)   pSF   P(MW)  Q(MVAR)   pST     MVA
dP(MW) dQ(MVAR)
-------- --------  --------------------   ---------------------  ------  ----
-------------
==============================================================================
==============
     110       10    -0.74     4.54  0.00    0.78    -4.11  0.00    40.00
0.036   0.430
      10       11     2.59     1.15  0.00   -2.52    -1.16  0.00     5.00
0.070  -0.015
 BRANCH is switched off
      11       12     0.00     0.00  0.00    0.00     0.00  0.00     5.00
0.000   0.000
      13       10    -7.25    -7.09  0.00    8.68     7.92  0.00     5.00
1.427   0.829
      13       12     7.25     7.09  0.00   -5.73    -6.19  0.00     5.00
1.517   0.901
      15       10    14.10     6.00  0.00  -12.60    -5.13  0.00    12.00
1.500   0.873
```

```
                                                                                ---
------  ---------
                                          TOTAL LOSSES    :    4.549   3.018

Time at the end of load flow computations: 0.04 secs
*** End of esrm() - see results in esrmout.m ***
```

8.3. Results for the Second strategy (Pg= 14.1 MW and Qg=-6 Mvar)

```
>> esrm

plikdat =

    'esrmdat61'


 ITERACJA =1  signdetJ = -1    normaNZB=     0.14100000
 ITERACJA =2  signdetJ = -1    normaNZB=     0.01846827
 ITERACJA =3  signdetJ = -1    normaNZB=     0.00337075
 ITERACJA =4  signdetJ = -1    normaNZB=     0.00039042
 ITERACJA =5  signdetJ = -1    normaNZB=     0.00000797

 Brak wezlow TYP=5

=============================================================================
===
Time after the solution of nodal equations: 0.05 secs

===============================================================
        typ    Um  Uk_st Un_kV  Pg(MW) Qg(MVAR) Pd(MW) Qd(MVAR)
```

```
    ----   ------------------  -------------- --------------
================================================================
     110  3 1.0000   0.0 110.00    0.62   18.48     -       -
      15  1 1.0094   7.2  10.00   14.10   -6.00     -       -
      10  1 0.9356   0.1  10.00    0.00    0.00    0.56    0.17
      11  1 0.9056  -0.2  10.00    0.00    0.00    2.51    1.16
      12  1 0.6083   5.4  10.00    0.00    0.00    5.73    6.19
      13  1 0.7758   2.1  10.00    0.00   -0.00     -       -
                                   -----   -----   -----   -----
                           SUM:    14.72   12.48    8.81    7.52

=============================================================================
==============
    FROM       To    FLOW at begin         FLOW at end      SMAX    BRANCH
losses
     BUS      BUS   P(MW)  Q(MVAR)   pSF   P(MW)  Q(MVAR)   pST     MVA
dP(MW) dQ(MVAR)
-------- --------  --------------------   --------------------  ------  ----
-------------
=============================================================================
==============
     110       10     0.62    18.48  0.00   -0.53   -16.96  0.00    40.00
0.098   1.521
      10       11     2.59     1.16  0.00   -2.52    -1.16  0.00     5.00
0.078  -0.004
 BRANCH is switched off
      11       12     0.00     0.00  0.00    0.00     0.00  0.00     5.00
0.000   0.000
      13       10    -7.75    -7.42  0.00    9.66     8.55  0.00     5.00
1.905   1.136
      13       12     7.75     7.42  0.00   -5.73    -6.19  0.00     5.00
2.022   1.226
      15       10    14.10    -6.00  0.00  -12.29     7.08  0.00    12.00
1.812   1.077
```

```
                                                                        ---
------  ---------
                                          TOTAL LOSSES    :    5.915   4.956


Time at the end of load flow computations: 0.06 secs


*** End of esrm() - see results in esrmout.m ***
```

9. Conclusion

The main points of this laboratory are summarized as follows.

For scenario 1: generation at bus 2(Pg=14.1MW, Qg=0Mvar)

- Total active Power generation 13.64MW, and total reactive power generation 11.06Mvar
- Total active power demand (Pd)= 8.81MW, and total Reactive power demand (Qd)= 7.52Mvar
- Active power loss=4.830MW, reactive power loss= 3.536Mvar

For scenario 2: generation at bus 2(Pg=14.1MW, Qg=6Mvar)

- Total active Power generation 13.36MW, and total reactive power generation 10.54Mvar
- Total active power demand (Pd)= 8.81MW, and total Reactive power demand (Qd)= 7.52Mvar
- Active power loss=4.549MW, reactive power loss= 3.018Mvar

For scenario 3: generation at bus 2(Pg=14.1MW, Qg= -6 Mvar)

- Total active Power generation 14.72MW, and total reactive power generation 12.48Mvar
- Total active power demand (Pd)= 8.81MW, and total Reactive power demand (Qd)= 7.52Mvar
- Active power loss=5.915MW, reactive power loss= 4.956Mvar

When the generator at bus 2 generates reactive power the power loss decreases and increases transmission efficiency. On the 0other hand, when it consumes reactive power the power loss increases as it is demonstrated in the above 3 scenarios.

Another very important point observed is the power loss is less in the messed network than in the radial network. The voltage profile is also better in the messed network than the radial network.