INDIAN INSTITUTE OF TECHNOLOGY , GUWAHATI

POWER ENGINEERING LAB

EE_572

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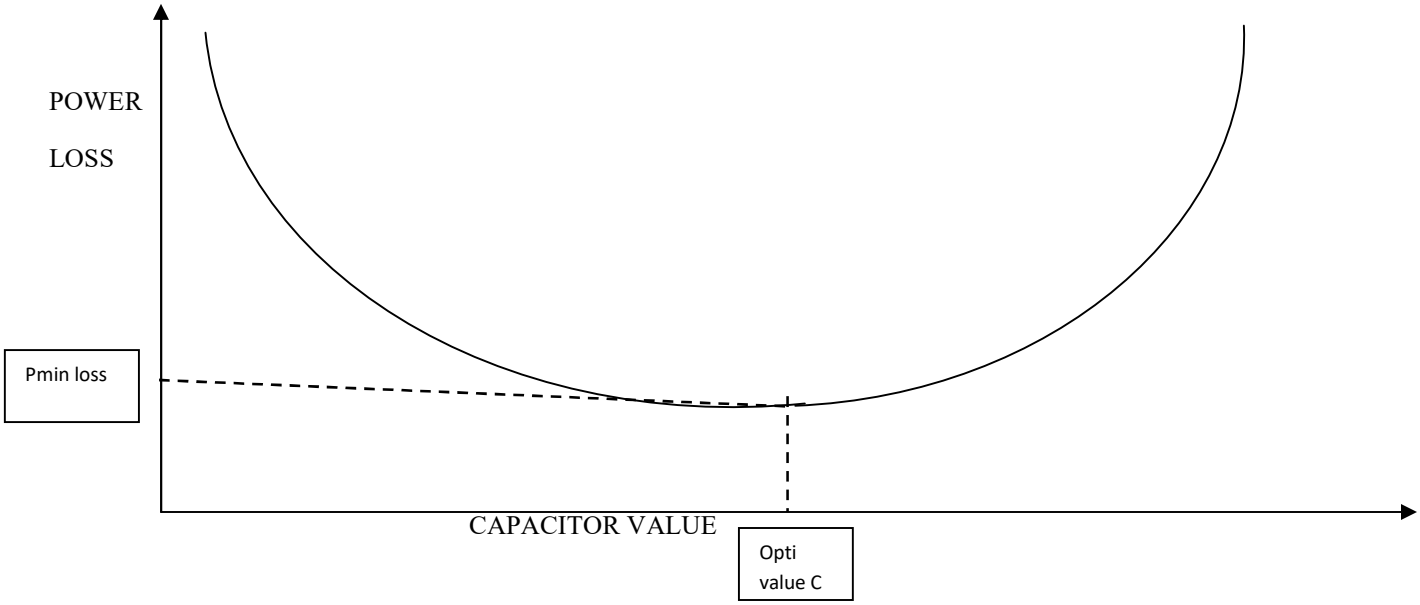
ASSIGNMENT–4 (part 2)

Place a capacitor bank, one at a time, in each node of a test network and show how the capacitor placement improves power loss and voltage profile.

We know that when we are place a capacitor on a bus then it injecting the negative reactive power to the bus due to this negative reactive power injection on bus then some amount of current is injected on bus and the magnitude of line current is reduce hence the line losses in system are also improve and voltage profile for the system also improve.

Line losses $=I^2.R$ (IF LINE CURRENT REDUCE THEN LOSSES ARE ALSO REDUCE)



In above figure I try to show the plot between power loss and value of capacitor . if we increase the value to capacitor then power loss is decreasing but after a limit the power loss further increasing with increasing the capacitor size so the power & capacitor value for the minimum power loss are Pmin and corresponding the value of capacitor.

We will do it for all the buses and we will find the minimum power loss among all the bus and corresponding the value of capacitor.

```
for bus_for_Q=1:length(busdata(:,1))-1

      bus_for_Q=bus_for_Q+1;

      plot_ploss=0;
      plot_Q=0;
      plot_iter=0;

      p_error=0;
      injected_Q=0;
      new_ploss=0;
      old_ploss=0;

    while p_error<=0
      old_ploss=new_ploss;

      assign_4
      new_ploss=Ploss;
    if injected_Q==0
      p_error=0;
      disp("injec = 0 ");

    else
      p_error = new_ploss-old_ploss;
      disp("injec not  0 ");
    end


     plot_iter=plot_iter+1;
     plot_ploss(plot_iter)=new_ploss;
     plot_Q(plot_iter)=injected_Q;


     injected_Q=injected_Q+1/(basemva*1000);
     disp("error of power = "+p_error+" new ploss = "+new_ploss+"old ploss =
"+old_ploss);
```

We will put our capacitor for all the bus so I make a for loop which will put capacitor at different-different bus

Checking the difference between old power loss and new power loss if difference is positive then stop the iteration and change the bus no for putting the capacitor

else we further increment in the capacitor value.

This `p_error is comparing in while loop`

Increment in the capacitor size by 1kvar

```
    end
    figure(2)
    plot(plot_Q*basemva*1000,plot_ploss*basemva*1000),

    hold on
    data_plmin(bus_for_Q,1)=bus_for_Q;
    data_plmin(bus_for_Q,2)=new_ploss*basemva*1000;
    data_plmin(bus_for_Q,3)=(injected_Q-1/(basemva*1000))*basemva*1000;
end
```

Code for plot b/w Ploss and C kvar

Minimum power loss for all bus in 33-bus system

Bus no.	Power loss(kw)	Capacitor value (KVAR)
1	0	0
2	198.914903528167	2545.99999999991
3	182.336072243439	2317.99999999992
4	175.403503265411	2085.99999999993
5	168.762468918649	1948.99999999994
6	154.415668968013	1792.99999999994
7	155.739345297206	1695.99999999995
8	161.087187970646	1384.99999999996
9	166.572148909341	1105.99999999997
10	169.874801862533	932.999999999979
11	170.383592281271	906.999999999980
12	171.381545740372	860.999999999982
13	174.671144111088	720.999999999987
14	175.726606121314	679.999999999989
15	177.186063944282	635.999999999991
16	178.816910548198	587.999999999993
17	181.269713151748	519.999999999996
18	182.513912740314	486.999999999997
19	200.995026321348	1018.99999999998
20	201.963669380584	252.000000000001
21	202.008261591548	219.000000000001
22	202.109179035172	175.000000000000
23	187.436910765179	1498.99999999996
24	190.240581269916	983.999999999977
25	192.518360420252	731.999999999987
26	153.849044505754	1718.99999999995
27	153.000059389826	1630.99999999995
28	148.857216250922	1413.99999999996
29	145.319988882683	1309.99999999996
30(Min power loss)	143.597932586212	1253.99999999997
31	150.006247657982	1079.99999999997
32	151.963476780873	1032.99999999997
33	154.413277035331	981.999999999977

Minimum power loss for all bus in 69-bus system

Bus no.	Power loss (KW)	Capacitor (kvar)
1	0	0
2	224.941469317306	3436.99999999978
3	224.904641873524	3436.99999999978
4	224.806517673536	3318.99999999980
5	223.994838559549	2387.99999999990
6	213.745188100469	2116.99999999993
7	203.141833642115	2082.99999999993
8	200.660690047848	2072.99999999993
9	199.450601446762	2063.99999999994
10	204.545876810848	1329.00000000002
11	204.966391502827	1248.00000000003
12	206.879249146029	1009.00000000002
13	209.487877774865	788.000000000012
14	210.831016195036	661.000000000009
15	211.595262859994	579.000000000006
16	211.692311465287	567.000000000006
17	211.935509093644	544.000000000005
18	211.939598536557	544.000000000005
19	212.292004351755	523.000000000005
20	212.498672517488	510.000000000004
21	212.806535187406	492.000000000004
22	212.826419565174	491.000000000004
23	213.050931879124	481.000000000004
24	213.506818715182	461.000000000003
25	214.452362356059	421.000000000002
26	214.794420634009	406.000000000001
27	214.985733579955	399.000000000001
28	224.962285890853	691.000000000010
29	224.974254848095	98.0000000000000
30	224.974046233632	39.0000000000000
31	224.973744166617	38.0000000000000
32	224.972125801220	34.0000000000000
33	224.968103994869	32.0000000000000
34	224.965506788559	25.0000000000000
35	224.968057799580	19.0000000000000
36	224.959765707934	743.000000000011
37	224.967226549271	161.000000000000
38	224.962849294548	120.000000000000
39	224.961357026637	116.000000000000
40	224.961312477763	116.000000000000
41	224.949225423787	72.0000000000001
42	224.943197274765	68.0000000000000
43	224.942397412996	68.0000000000000

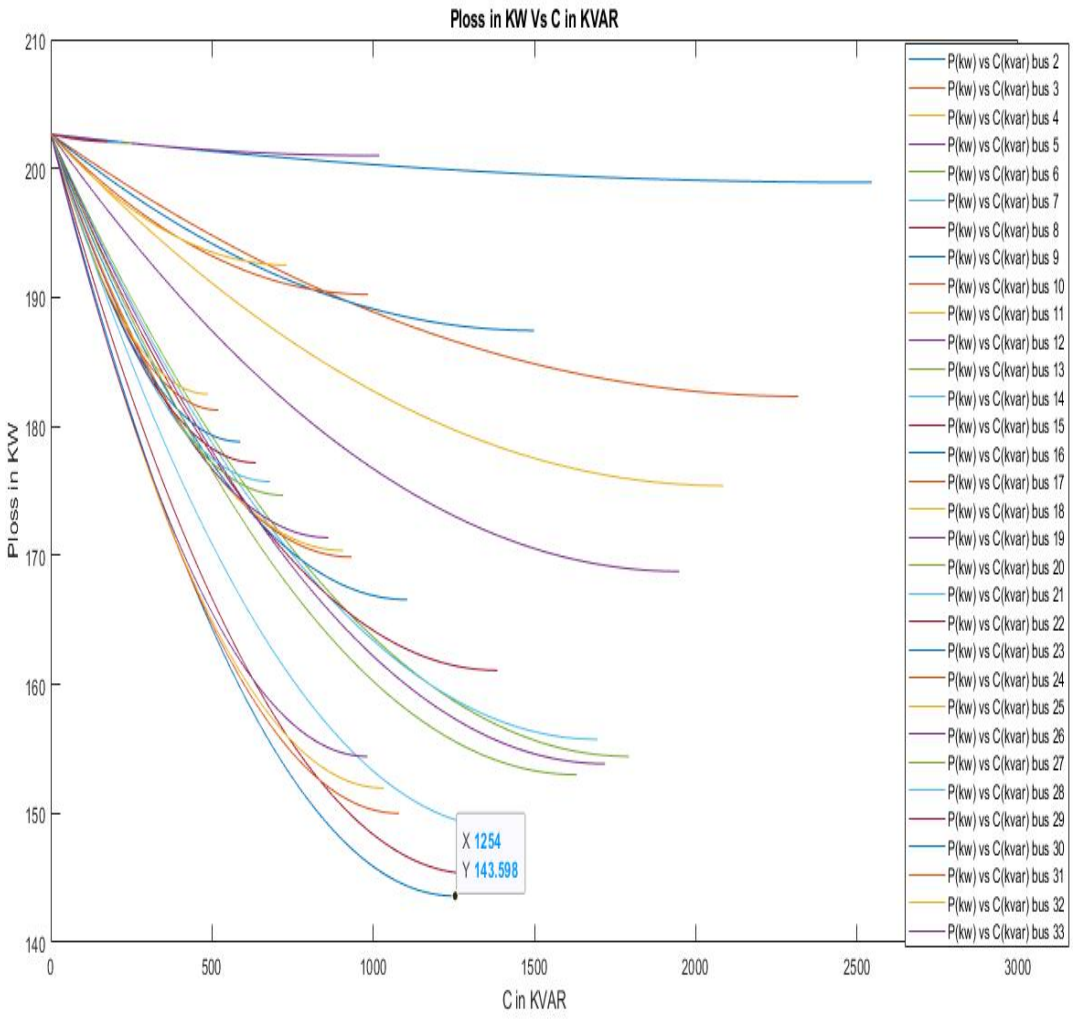
44	224.942251623788	68.0000000000000
45	224.940493233897	67.0000000000000
46	224.940498669931	67.0000000000000
47	224.864036164666	1762.99999999997
48	224.707894964011	690.000000000010
49	224.158937404226	585.000000000007
50	224.160575091219	530.000000000005
51	202.979708672840	1871.99999999996
52	208.686747407710	1385.00000000001
53	197.785026582638	1945.99999999995
54	195.705043007586	1845.99999999996
55	192.761172744357	1743.99999999997
56	189.844757080057	1669.99999999998
57	172.936232648634	1455.00000000000
58	164.228817940387	1402.00000000001
59	160.809688070705	1385.00000000001
60	157.048888748729	1360.00000000001
61(Min power loss)	152.037848429923	1331.00000000002
62	152.952570050822	1310.00000000002
63	154.320288521539	1279.00000000002
64	160.042484577490	1149.00000000002
65	169.051162431223	983.000000000018
66	206.816413585375	1130.00000000002
67	206.856304256212	1127.00000000002
68	210.592289643792	793.000000000013
69	210.611634943051	792.000000000013

Minimum power loss for all bus in 52-bus system

Bus no.	Power loss (KW)	Capacitor (kvar)
1	0	0
2	776.964100353974	725.000000000001
3	784.660896809126	303.000000000000
4	771.895024811284	670.000000000001
5	776.356331090592	506.000000000000
6	769.953197252548	626.000000000001
7	775.658883009889	456.000000000000
8	766.050991376933	547.000000000000
9	763.352225712201	476.000000000000
10	760.196818770457	398.000000000000
11	762.281580264416	365.000000000000
12	763.591306156942	173.000000000000
13	791.747629611079	53.0000000000000
14	766.935152016551	297.000000000000
15	791.789456846519	51.0000000000000

16	760.731431464616	373.000000000000
17	768.084436197615	274.000000000000
18	764.533089330521	300.000000000000
19	767.998369995948	254.000000000000
20	788.967643312775	579.000000000001
21	788.472838155201	391.000000000000
22	787.473960769142	295.000000000000
23	787.815573417185	202.000000000000
24	788.195212588118	172.000000000000
25	788.260490364833	213.000000000000
26	789.227426252208	150.000000000000
27	788.906858611036	411.000000000000
28	789.419040739168	281.000000000000
29	790.211683613905	177.000000000000
30	789.979780508826	188.000000000000
31	790.384365133559	123.000000000000
32	714.759355561171	1301.99999999997
33	640.829999015289	1052.00000000000
34	691.725668104420	679.000000000001
35	673.616346556047	750.000000000001
36	696.840780071033	562.000000000000
37	709.219783967110	479.000000000000
38	690.910277928182	631.000000000001
39	629.466867944638	910.000000000001
40	655.064080112366	749.000000000001
41(Min power loss)	625.507441040571	792.000000000001
42	657.251549711854	621.000000000001
43	665.154739193581	566.000000000000
44	690.554156571110	429.000000000000
45	629.723452807587	723.000000000001
46	662.518621523909	558.000000000000
47	641.429691630478	622.000000000001
48	655.140041794015	559.000000000000
49	649.104249212132	570.000000000000
50	675.125933797078	450.000000000000
51	658.747555085223	521.000000000000
52	665.846188447639	490.000000000000

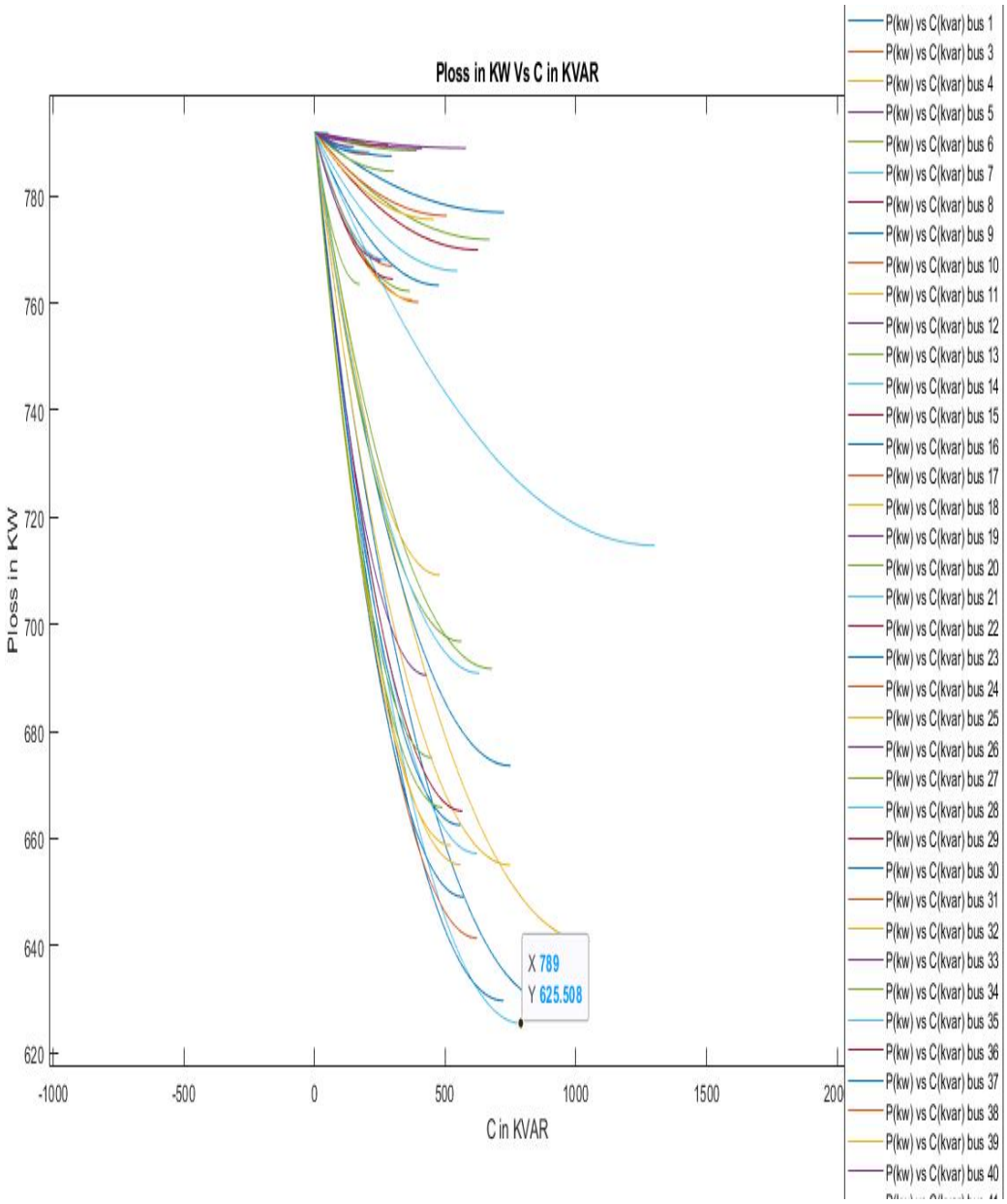
Plot between Ploss(kw) and capacitor value(kvar) for each bus of 33-bus system



In this plot you can see that minimum power loss is obtain for capacitor size of 1254KVAR and loss 143.598KW at bus no. 30

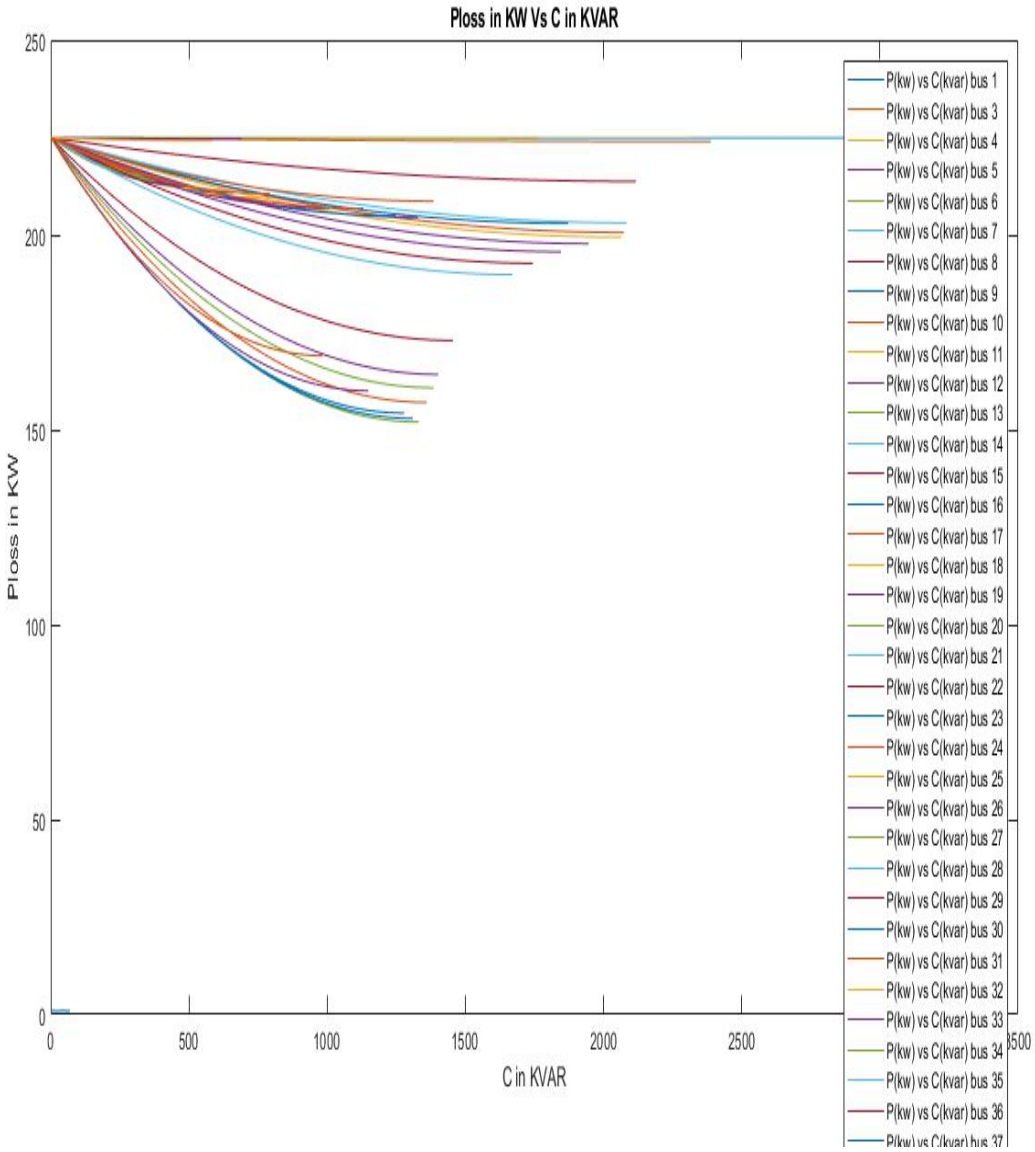
Similarly we can make plot for all bus system (for 69-bus system & 52-bus system)

Plot between Ploss(kw) and capacitor value(kvar) for each bus of 52-bus system



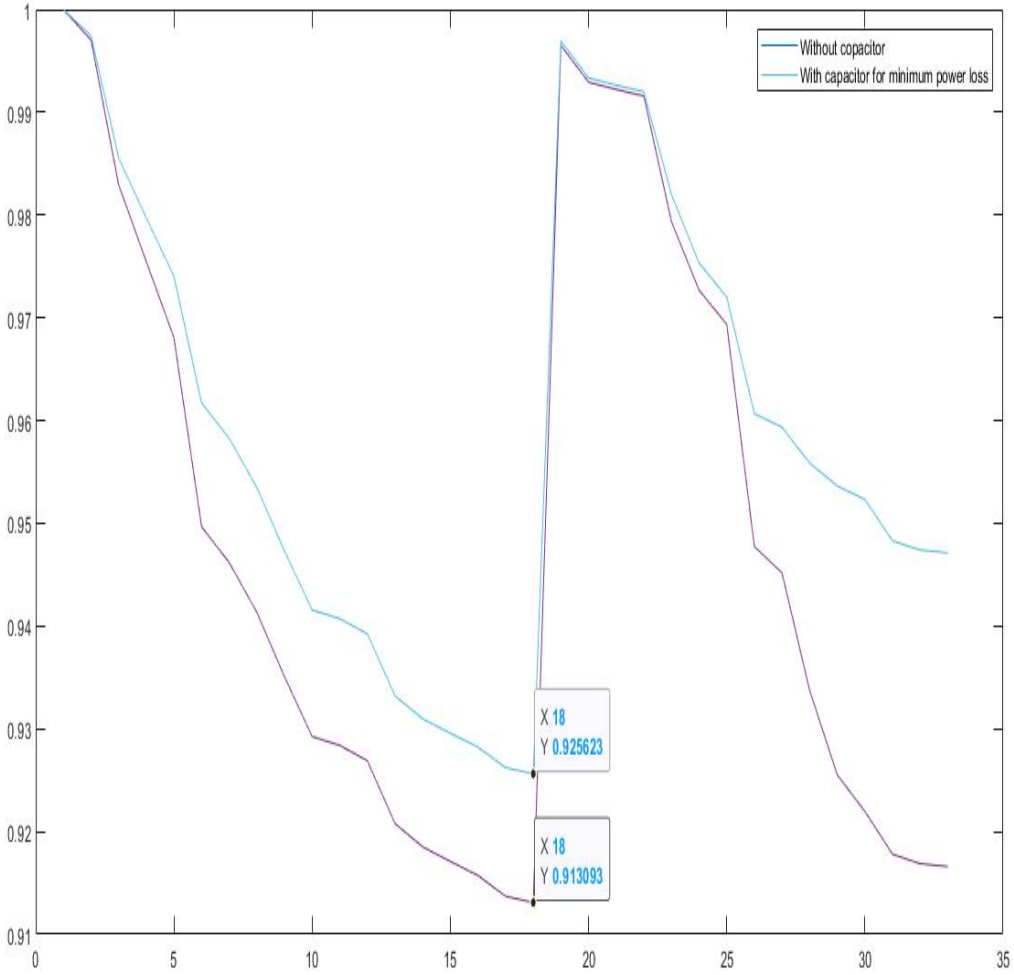
In this plot you can see that minimum power loss is obtain for capacitor size of 789KVAR and loss 625.508KW at bus no. 41

Plot between Ploss(kw) and capacitor value(kvar) for each bus of 69-bus system



In this plot you can see that minimum power loss is obtain for capacitor size of 1331KVAR and loss 152.037KW at bus no. 61

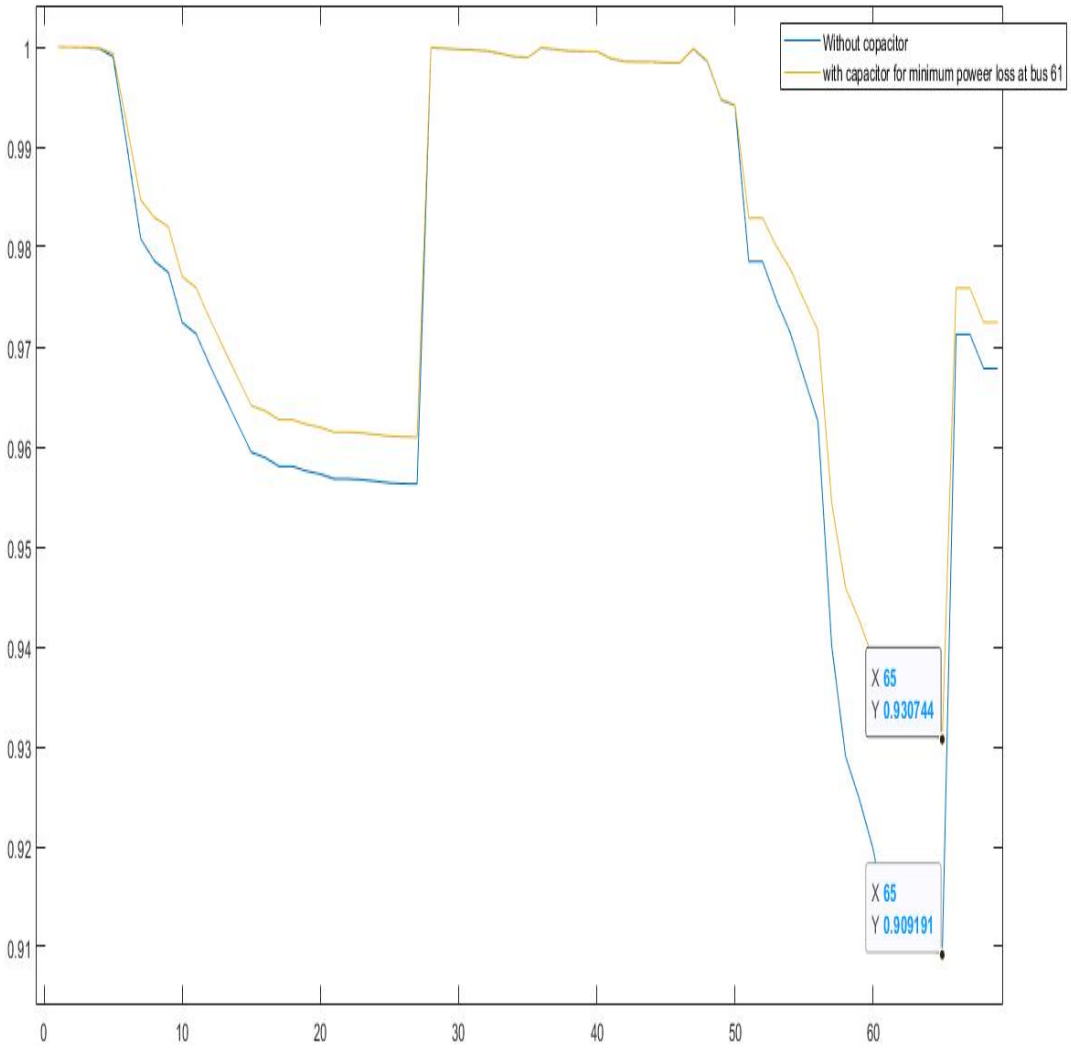
Voltage profile after putting capacitor for minimum power loss. 33-bus



You can see that without capacitor the minimum voltage at bus no 18 is 0.9131 p.u. but after putting the capacitor for reducing the losses the it become 0.9256 p.u. so voltage is increased after putting the capacitor.

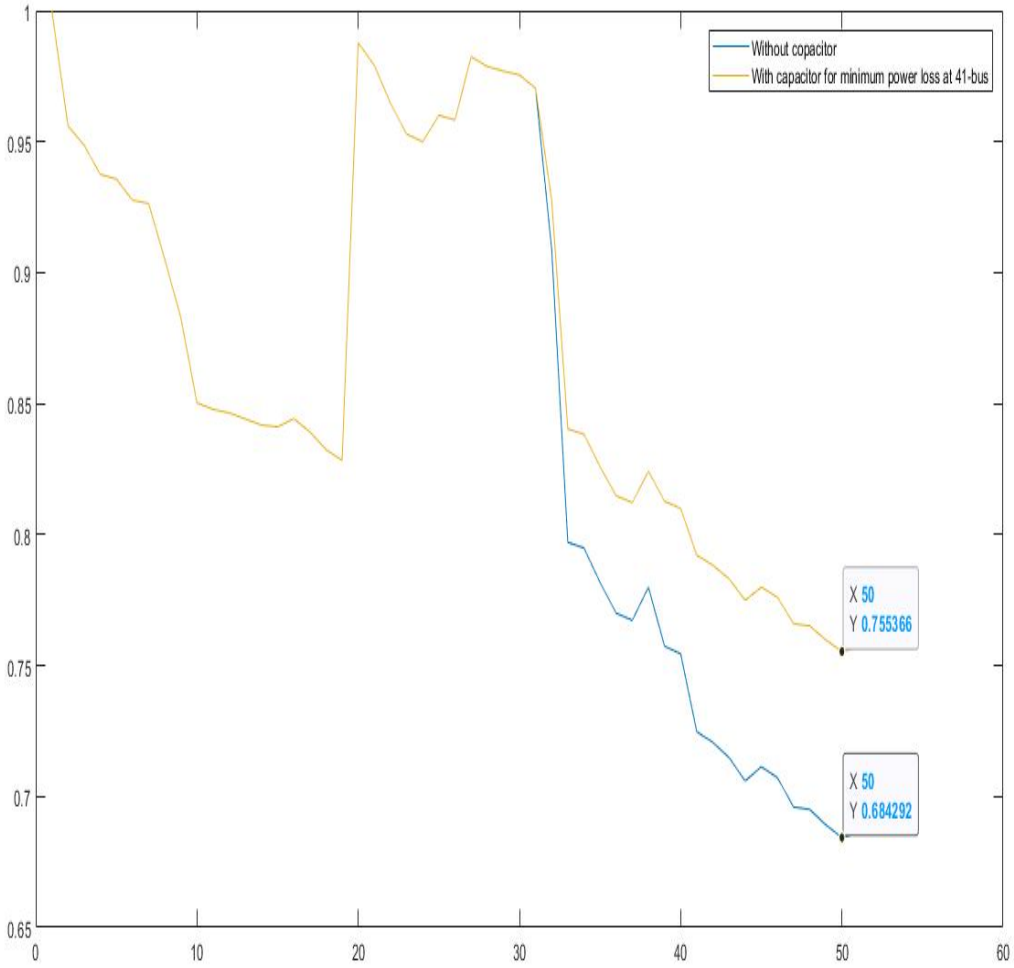
Similarly for the other bus system also.

Voltage profile after putting capacitor for minimum power loss. 69-bus



You can see that without capacitor the minimum voltage at bus no 65 is 0.9091 p.u. but after putting the capacitor for reducing the losses the it become 0.9307 p.u. so voltage is increased after putting the capacitor.

Voltage profile after putting capacitor for minimum power loss. 52-bus



You can see that without capacitor the minimum voltage at bus no 41 is 0.6843 p.u. but after putting the capacitor for reducing the losses the it become 0.755 p.u. so voltage is increased after putting the capacitor

Complete result for the part-2

Results	33-bus	69-bus	52-bus
Min. Ploss(KW)	143.59	152	625.50
Location (bus)	30^{th} bus	61^{th} bus	41^{th} bus
Size of capacitor(KVAR)	1254	1331	792
Min. voltage without cap.	0.9131 at 18^{th} bus	0.9091 at 65^{th} bus	0.6843 at 50^{th} bus
Min voltage with cap	0.9256 at 18^{th} bus	0.93074 at 65^{th} bus	0.75536 at 50^{th} bus