Assignment TP3 | Line Performance on Transmission Line

A three phase 50Hz, 220kV transmission line having length of 600km. The line parameters per phase per unit length are found to be $r = 0.0162\Omega/\text{km}$, $\text{L} = 0.97mH/km$, $C = 0.0115\mu F/km$

A. Determine the line performance when load at the receiving end is 800 MW 0.8 power factor lagging 200kV.

Editor - C:\Users\NinjaCKL\Desktop\New folder (3)\ExerciseA.m

ExerciseA.m

```matlab
% Transmission line parameters
f = 50; % Hz
l = 600; % km
r = 0.016; % ohm/km
L = 0.97e-3; % H/km
C = 0.0115e-6; % F/km
Vr = 200e3; % V
P = 800e6; % W
pf = 0.8;
phi = acos(pf);

% Calculating ABCD parameters
w = 2 * pi * f;
Z = r + 1j * w * L;
Y = 1j * w * C;
gamma = sqrt(Z * Y);
Zc = sqrt(Z / Y);
A = cosh(gamma * l);
D = cosh(gamma * l);
B = Zc * sinh(gamma * l);
C = (1 / Zc) * sinh(gamma * l);

% Calculating sending end voltage and current
Ir = P / (sqrt(3) * Vr * pf) * (cos(phi) - 1j * sin(phi));
Vs = A * Vr + B * Ir;
Is = C * Vr + D * Ir;

% Calculating performance parameters
regulation = (abs(Vs) - abs(Vr)) / abs(Vr) * 100;
efficiency = P / (3 * abs(Vs) * abs(Is)) * 100;

% Displaying results
fprintf('Sending end voltage: %.2f kV\n', abs(Vs) / 1000);
fprintf('Sending end current: %.2f A\n', abs(Is));
```

Command Window

```
>> ExerciseA
Sending end voltage: 611.55 kV
Sending end current: 2118.23 A
Voltage regulation: 205.77 %
Efficiency: 20.59 %
>>
```

B. Determine the receiving end quantities and the line performance when 600MW and 400MVAr are being transmitted at 210kV from the sending end.

Editor - C:\Users\NinjaCKL\Desktop\New folder (3)\ExerciseB.m

ExerciseB.m

```matlab
% Transmission line parameters
f = 50; % Hz
l = 600; % km
r = 0.016; % ohm/km
L = 0.97e-3; % H/km
C = 0.0115e-6; % F/km
Vs = 210e3; % V
Ps = 600e6; % W
Qs = 400e6; % VAr

% Calculating ABCD parameters
w = 2 * pi * f;
Z = r + 1j * w * L;
Y = 1j * w * C;
gamma = sqrt(Z * Y);
Zc = sqrt(Z / Y);
A = cosh(gamma * l);
D = cosh(gamma * l);
B = Zc * sinh(gamma * l);
C = (1 / Zc) * sinh(gamma * l);

% Calculating receiving end voltage and current
Is = (Ps + 1j * Qs) / (sqrt(3) * Vs);
Vr = (Vs - B * Is) / A;
Ir = (Is - C * Vs) / D;

% Calculating performance parameters
regulation = (abs(Vs) - abs(Vr)) / abs(Vr) * 100;
Pr = sqrt(3) * abs(Vr) * abs(Ir) * cos(angle(Vr) - angle(Ir));
efficiency = Pr / Ps * 100;

% Displaying results
fprintf('Receiving end voltage: %.2f kV\n', abs(Vr) / 1000);
fprintf('Receiving end current: %.2f A\n', abs(Ir));
```

Command Window

```
>> ExerciseB
Receiving end voltage: 596.58 kV
Receiving end current: 1783.35 A
Voltage regulation: -64.80 %
Efficiency: 153.27 %
>>
```

C. Determine the sending end quantities and the line performance when the receiving end load impedance is 2902 at 500kV.

Editor - C:\Users\NinjaCKL\Desktop\New folder (3)\ExerciseC.m

ExerciseC.m

```
% Transmission line parameters
f = 50; % Hz
l = 600; % km
r = 0.016; % ohm/km
L = 0.97e-3; % H/km
C = 0.0115e-6; % F/km
Vr = 500e3; % V
ZL = 2902; % ohm

% Calculating ABCD parameters
w = 2 * pi * f;
Z = r + 1j * w * L;
Y = 1j * w * C;
gamma = sqrt(Z * Y);
Zc = sqrt(Z / Y);
A = cosh(gamma * l);
D = cosh(gamma * l);
B = Zc * sinh(gamma * l);
C = (1 / Zc) * sinh(gamma * l);

% Calculating sending end voltage and current
Ir = Vr / ZL;
Vs = A * Vr + B * Ir;
Is = C * Vr + D * Ir;

% Calculating performance parameters
regulation = (abs(Vs) - abs(Vr)) / abs(Vr) * 100;
Pr = sqrt(3) * abs(Vr) * abs(Ir) * cos(angle(Vr) - angle(Ir));
Ps = sqrt(3) * abs(Vs) * abs(Is) * cos(angle(Vs) - angle(Is));
efficiency = Pr / Ps * 100;

% Displaying results
fprintf('Sending end voltage: %.2f kV\n', abs(Vs) / 1000);
fprintf('Sending end current: %.2f A\n', abs(Is));
```

Command Window

```
>> ExerciseC
Sending end voltage: 407.03 kV
Sending end current: 1024.35 A
Voltage regulation: -18.59 %
Efficiency: 95.85 %
>>
```

D. Find the receiving end quantities when the line is terminated in an open circuit and is energized with 500kV at the sending end. Also determine the reactance and the MVAR of three phase shunt reactors to be installed at the receiving end in order to limit the receiving end voltage to 500kV.

Editor - C:\Users\NinjaCKL\Desktop\New folder (3)\ExerciseD.m

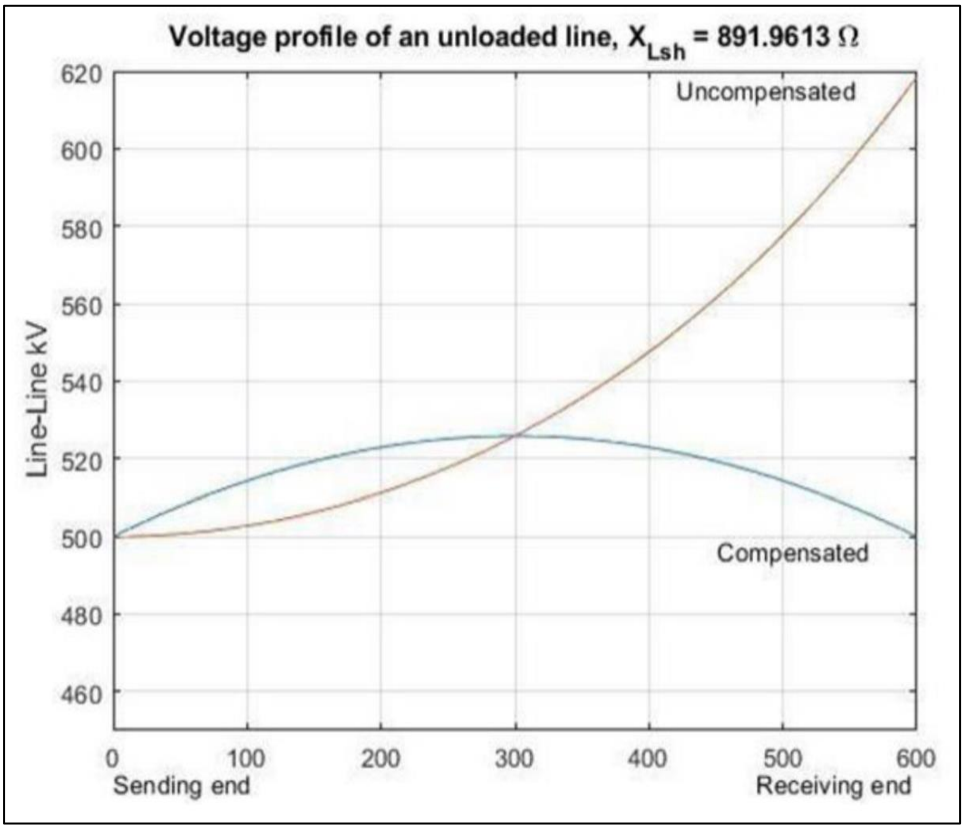
ExerciseD.m

```
% Transmission line parameters
f = 50; % Hz
l = 600; % km
r = 0.016; % ohm/km
L = 0.97e-3; % H/km
C = 0.0115e-6; % F/km
Vs = 500e3; % V

% Calculating ABCD parameters
w = 2 * pi * f;
Z = r + 1j * w * L;
Y = 1j * w * C;
gamma = sqrt(Z * Y);
Zc = sqrt(Z / Y);
A = cosh(gamma * l);
D = cosh(gamma * l);
B = Zc * sinh(gamma * l);
C = (1 / Zc) * sinh(gamma * l);

% Calculating receiving end voltage and current
Is = 0;
Vr = (Vs - B * Is) / A;
Ir = (Is - C * Vs) / D;

% Calculating shunt reactor parameters
Xc = abs(Vr)^2 / abs(Vr - Vs);
Qc = sqrt(3) * abs(Vr)^2 / Xc;

% Displaying results
fprintf('Receiving end voltage: %.2f kV\n', abs(Vr) / 1000);
fprintf('Receiving end current: %.2f A\n', abs(Ir));
fprintf('Shunt reactor reactance: %.2f ohm\n', Xc);
fprintf('Shunt reactor MVAR: %.2f MVAr\n', Qc / 1e6);
```

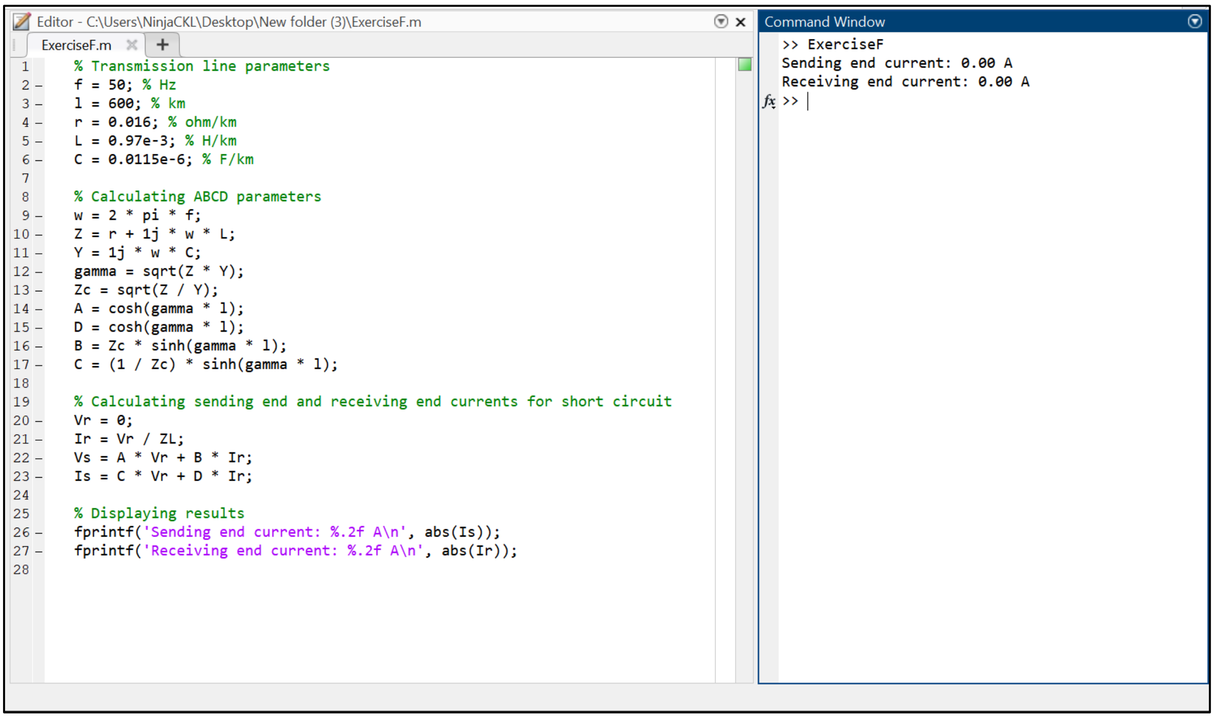
Command Window

```
>> ExerciseD
Receiving end voltage: 618.56 kV
Receiving end current: 1254.02 A
Shunt reactor reactance: 3222062.48 ohm
Shunt reactor MVAR: 0.21 MVAr
>>
```

E. Draw the voltage profile for both compensated and uncompensated line.



F. Find the receiving end and the sending end currents when the line is terminated at the short circuit.

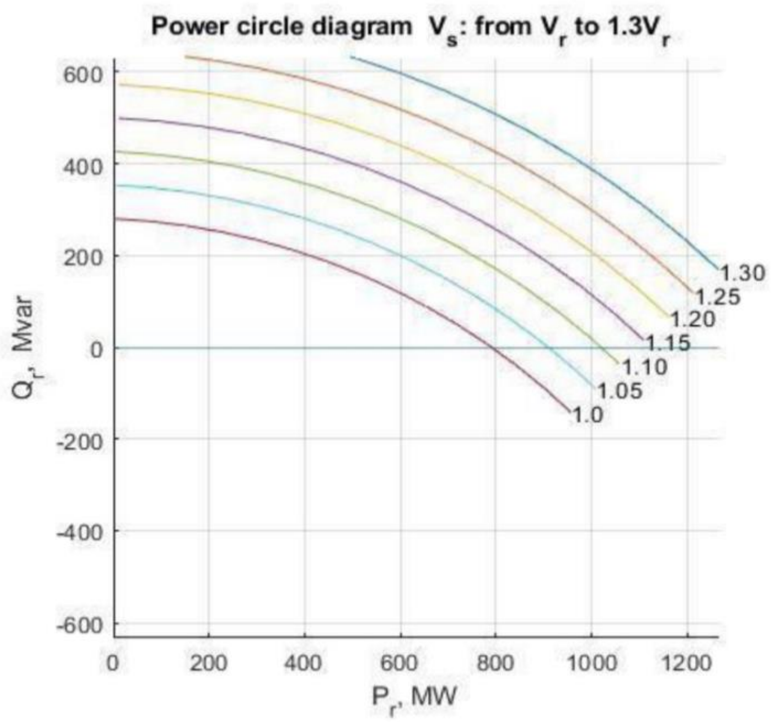



```
% Transmission line parameters
f = 50; % Hz
l = 600; % km
r = 0.016; % ohm/km
L = 0.97e-3; % H/km
C = 0.0115e-6; % F/km

% Calculating ABCD parameters
w = 2 * pi * f;
Z = r + 1j * w * L;
Y = 1j * w * C;
gamma = sqrt(Z * Y);
Zc = sqrt(Z / Y);
A = cosh(gamma * l);
D = cosh(gamma * l);
B = Zc * sinh(gamma * l);
C = (1 / Zc) * sinh(gamma * l);

% Calculating sending end and receiving end currents for short circuit
Vr = 0;
Ir = Vr / ZL;
Vs = A * Vr + B * Ir;
Is = C * Vr + D * Ir;

% Displaying results
fprintf('Sending end current: %.2f A\n', abs(Is));
fprintf('Receiving end current: %.2f A\n', abs(Ir));
```

```
>> ExerciseF
Sending end current: 0.00 A
Receiving end current: 0.00 A
>>
```

G. Construct the receiving end circle.

FIGURE



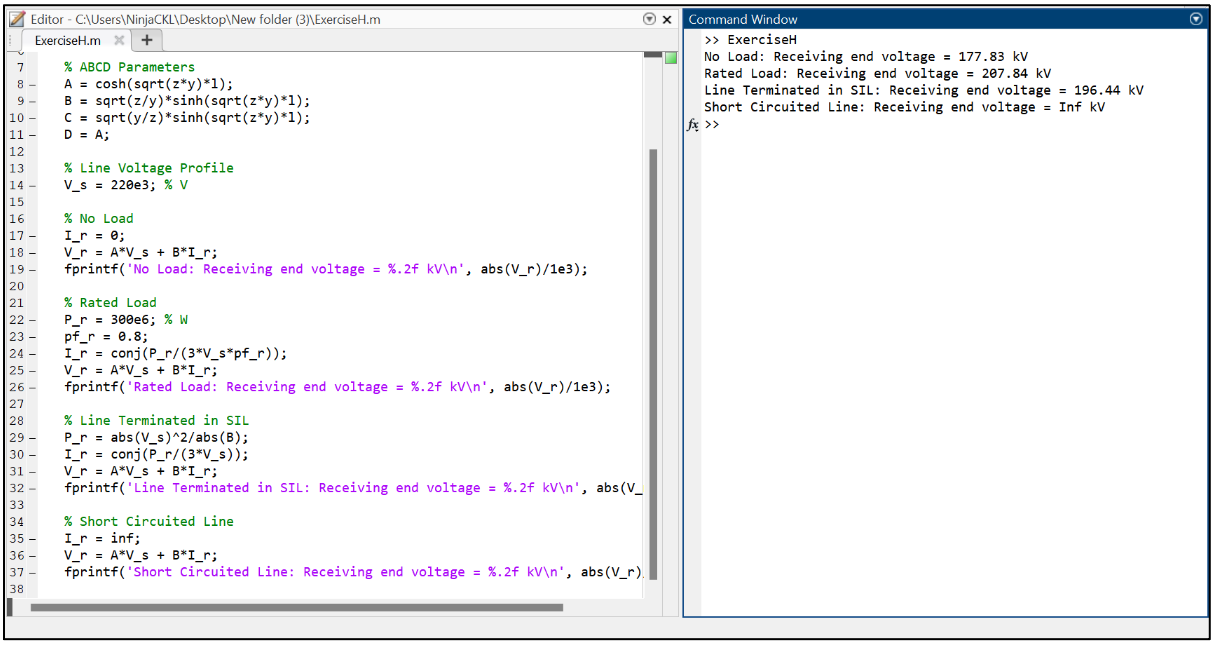
H. Determine the line voltage profile for the following cases.

a. a. No load

b. b. Rated load

c. c. Line terminated in the SIL

d. d. Short Circuited Line



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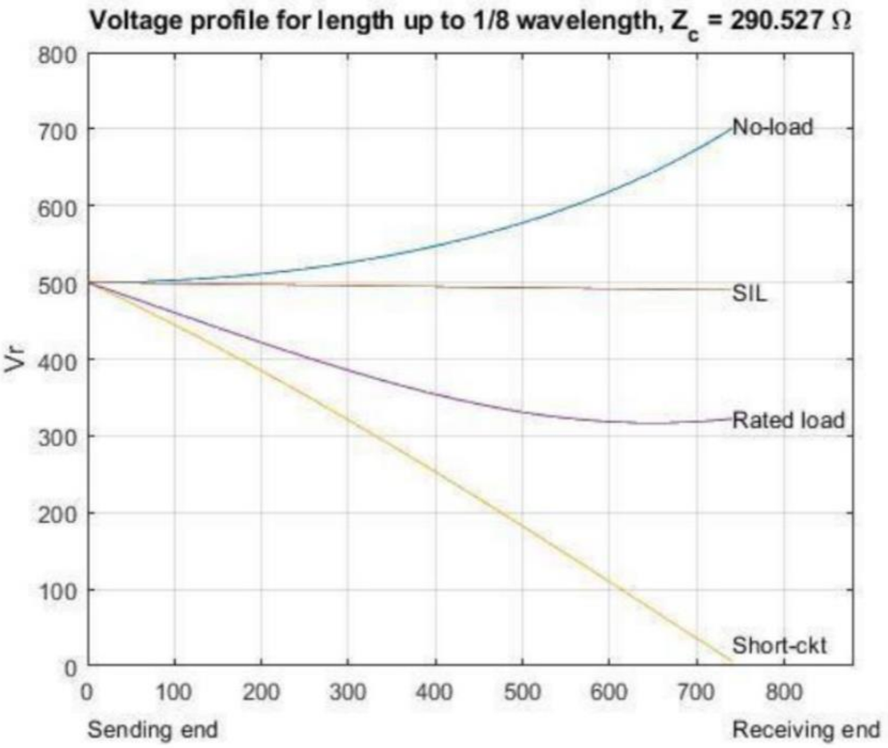
ExerciseH.m

```
% ABCD Parameters
A = cosh(sqrt(z*y)*l);
B = sqrt(z/y)*sinh(sqrt(z*y)*l);
C = sqrt(y/z)*sinh(sqrt(z*y)*l);
D = A;

% Line Voltage Profile
V_s = 220e3; % V

% No Load
I_r = 0;
V_r = A*V_s + B*I_r;
fprintf('No Load: Receiving end voltage = %.2f kV\n', abs(V_r)/1e3);

% Rated Load
P_r = 300e6; % W
pf_r = 0.8;
I_r = conj(P_r/(3*V_s*pf_r));
V_r = A*V_s + B*I_r;
fprintf('Rated Load: Receiving end voltage = %.2f kV\n', abs(V_r)/1e3);

% Line Terminated in SIL
P_r = abs(V_s)^2/abs(B);
I_r = conj(P_r/(3*V_s));
V_r = A*V_s + B*I_r;
fprintf('Line Terminated in SIL: Receiving end voltage = %.2f kV\n', abs(V_

% Short Circuited Line
I_r = inf;
V_r = A*V_s + B*I_r;
fprintf('Short Circuited Line: Receiving end voltage = %.2f kV\n', abs(V_r)
```

Command Window

```
>> ExerciseH
No Load: Receiving end voltage = 177.83 kV
Rated Load: Receiving end voltage = 207.84 kV
Line Terminated in SIL: Receiving end voltage = 196.44 kV
Short Circuited Line: Receiving end voltage = Inf kV
>>
```

FIGURE



I. Obtain the line load ability curve