TD 1 : Fundamentals of AC Systems

Exercise 1

If $v = 106{,}1\cos\left(\omega t + \frac{\pi}{3}\right)\ V$ and $i = 14{,}14\sin\left(\omega t + \frac{2\pi}{3}\right)\ A$, Find for both v and i

a) the maximum value; b) the rms value;

c) the phasor expression if voltage is the reference;

d) Is the circuit inductive or capacitive?

Exercise 2

If the circuit of exercise 1 consists of a purely resistive R and a reactive element X, find R and X:

a) if the elements are in series; b) if the elements are in parallel.

Exercise 3

In a single-phase circuit $\overline{V_1} = 100\angle 30°\ V$ and $\overline{V_2} = 120\angle 60°\ V$ with respect to a reference O. Find $\overline{V_{21}}$.

Exercise 4

A single-phase ac voltage of 240V is applied to a series circuit whose impedance is $10\angle 60°\ \Omega$. Find R, X, P, Q and the power factor of the circuit.

Exercise 5

If a capacitor is connected in parallel with the circuit of Exercise 4 and if this capacitor supplies 1250 VAr, find the P and Q supplied by the source, and find the resultant power factor.

Exercise 6

A single-phase load draws a current of $30\angle 35°\ A$. The voltage across the load is $220\angle 75°\ V$. Find P and Q of the load.

Exercise 7

A single-phase inductive load draws 7500W at 0.8 power factor lagging. Draw the power triangle and determine the reactive power of a capacitor to be connected in parallel with the load to raise the power factor to 0.9.

Exercise 8

A voltage source $E_{1n} = 100\angle 30°\ V$ and the current through the source is given by $\overline{I_{n1}} = -10\angle 240°\ A$. Find the values of P and Q and state whether the source is delivering or receiving each.

Exercise 9

A 380 V, 50 Hz three-phase supply is applied to a balanced Δ-connected three phase load consisting of resistance $R = 20\ \Omega$ in series with inductance $L = 0.1\ H$ per phase. Calculate a) the phase current J, b) the line current I, c) the active, reactive and apparent power supplied to the load, d) the power factor $cos\varphi$.

Exercise 10

In a balanced three-phase system, a balanced three phase load draws a line current $\overline{I_1} = 25\angle -90°\ A$ for a voltage $\overline{V_1} = 120\angle 0°\ V$. Find the impedance of the load in case of a) Y-connected load b) D-connected load.

Exercise 11

In a balanced three-phase system the Y-connected impedances are $10\angle 30°\ \Omega$. If $\overline{V_{31}} = 416\angle 90°\ V$, specify I_2 in polar form.

Exercise 12

A 4157 V three-phase supply is applied to a balanced Y-connected three phase load consisting of three identical impedances of $48\angle 36.87°$. Taking the phase to neutral voltage V_1 as reference, calculate (a) The phasor currents in each line. (b) The total active and reactive power supplied to the load.

Exercise 13

Repeat Exercise 12 with the same three-phase impedances arranged in a Δ connection. Take V_{12} as reference.

Exercise 14

A 600V, 50Hz three-phase source feeds a balanced-Y load consisting of impedances $Z_1 = 50\angle -60°\ \Omega$ per phase in parallel with a balanced–Δ load of impedances $Z_2 = 42\angle 30°\ \Omega$ per phase. Find the line currents (in polar form) I_1, I_2 et I_3 supplied by the source.

Exercise 15

On a 220/380 V, 50 Hz mains supply, three loads are connected in a star configuration with a neutral:

- between phase 1 and neutral: Z_1=55 Ω, cosφ_1=0,8 (inductive load);
- between phase 2 and neutral: Z_2=44 Ω, cosφ_2=1 (resistive load);
- between phase 3 and neutral: Z_3=110 Ω, cosφ_3=0 (capacitive load).

Calculate the currents flowing through the loads and the neutral wire.

Exercise 16

On a 220/380 V, 50 Hz mains supply, are connected in a delta configuration:

- between phases 1 and 2, a resistor R_1 of 95 Ω;
- between phases 2 and 3, a resistor R_2 of 168 Ω in series with an inductor L of 0.32 H;
- between phases 3 and 1, a resistor R_3 of 725 Ω in parallel with a capacitor C of 4 µF.

Calculate the currents in each of the loads as well as the three line currents.

Exercise 17

A balanced three-phase load draws 30 KVA at 0.8 power factor lagging from a 231/400 V source. Give the values of powers P, Q et S. Determine the phasor of currents I_1, I_2 and I_3 supplied by the source.

Exercise 18

A three-phase load draws 260 KW at a power factor of 0.707 lagging from a 400 V line. In parallel with this load is a three-phase capacitor bank which draws 60 kVA. Find the total current and resultant power factor.

Exercise 19

Three parallel 3-phase loads are supplied from a 400 V, 50 Hz three-phase supply. The loads are as follows:

- Load 1: Motors operating at full-load, absorbing a total of 95000 W with 0.6 lagging power factor.
- Load 2: A balanced resistive load that draws a total of 42000 W.
- Load 3: A Δ-connected capacitor bank with a total rating of 9700 VAr.

a) Calculate

1) the total system active and reactive power
2) the supply current per phase;
3) the system power factor
4) the capacitor value in µF per phase.

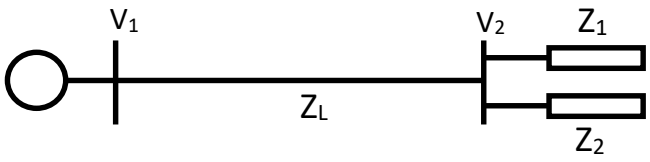
b) What is the system power factor and the supply current per phase when the resistive load and induction motors are operating but the capacitor bank is switched off?

Exercise 20

$Z_1 = 8 + j6\ \Omega$ and $Z_2 = 12 - j8\ \Omega$ star connected

$Z_L = 0.5 + j1.2\ \Omega$

$V_1 = 280\ V$



Calculate :

1) the line current I and the complex power supplied by the source;
2) the voltage across the load $V_{2;}$
3) the current and power of each load as well as the complex power consumed by the line.

Exercise 21

$Z_L = 0.5 + j2.2\ \Omega$; $V_2 = 1.4\ kV$. Calculate:

1) the total complex power of the two loads
2) the line current I
3) the voltage at the source
4) the power supplied by the source and that consumed by the line.