A3 Simulative Engineering - Formulary

Contents

1 Resources for the exam

Allowed:

- ✓ Your hand written Lecture notes
- ✓ Summary of your handwritten lectures
- ✓ This formulary
- ✓ Mathematical book e.g.Papula
- ✓ DHBW Calculator (or just use MATLAB)

Not allowed:

- × Solutions of the laboratory
- × Learning paper

Good luck!

2 Laplace

How to transform signals?

Derivatives	Integrals
$y(t) \circ\!\!-\!\!\bullet Y(s)$	$\int y(t)dt \circ\!\!-\!\!\bullet \frac{1}{s}Y(s)$
$y'(t) \circ\!\!-\!\!\bullet sY(s)$	$\int\int y(t)dt \circ\!\!-\!\!\bullet \frac{1}{s^2}Y(s)$
$y''(t) \circ\!\!-\!\!\bullet s^2Y(s)$	$\int\int\int y(t)dt \circ\!\!-\!\!\bullet \frac{1}{s^3}Y(s)$
and so on...	and so on...

3 Electronical formulas

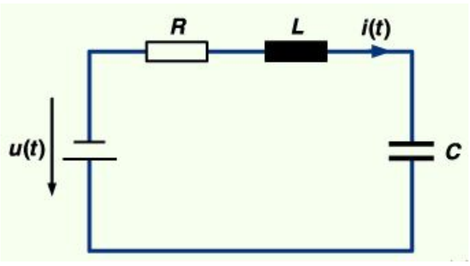

Figure 1: RLC circuit

3.1 Resistor

$$u_R(t) = R \cdot i_R(t) \tag{1}$$

U: voltage [Volt V]
R: restistance [Ohm $\Omega = \frac{V}{A}$]
I: current [Ampere A]

3.2 Capacitor/Condenser

$$Q = C \cdot U_C \tag{2}$$
$$Q = \int i_C(t) \tag{3}$$
$$i_C(t) = C \cdot u'_C(t) \tag{4}$$

Q: electric charge [Coulomb C = As]
C: capacity [Farad F = $\frac{C}{V}$]

3.3 Inductor

$$u_L(t) = L \cdot i'_L(t) \tag{5}$$

L: inductance [Henry H = $\frac{Vs}{A}$]

4 Mechanical formulas

4.1 Newton's Second Law

$$F = m \cdot a = m \cdot x''(t) \tag{6}$$

m: mass [gramm g]
a: acceleration $[\frac{m}{s^2}]$ x: length [meter m]

4.2 Gravitational force

$$F_G = m \cdot g \tag{7}$$

g: gravitational acc. $[\frac{m}{s^2}]$ (Germany 9.81 $\frac{m}{s^2}$)

4.3 Spring force

$$F_S = k \cdot x \tag{8}$$

k: spring constant $[\frac{kg}{s^2}]$

4.4 Friction force

$$F_F = r \cdot v = r \cdot x'(t) \tag{9}$$

r: friction constant
v: velocity $[\frac{m}{s}]$

4.5 Rotational force

$$F_R = F_G \cdot \sin\rho \tag{10}$$

ρ: angle of displacement

4.6 Torque

$$M = F \cdot r \tag{11}$$

r: radius

4.7 Rotational movement

$$M = J \cdot \rho'' \tag{12}$$

J: moment of inertia
ρ'': angular velocity

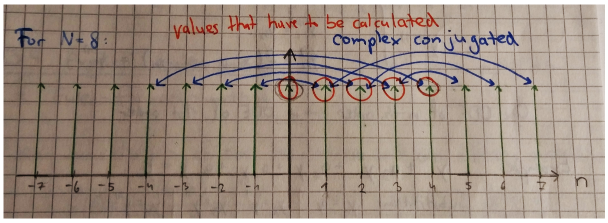

Figure 2: Complex conjugated values

5 DFT

Fourier Transform transforms time continuos values in time domain into values in frequency domain.

$$u(t) \circ\!\!-\!\!\!-\!\!\bullet \underline{U}(f) = \int_{-\infty}^{+\infty} u(t) \cdot \mathrm{e}^{-j2\pi ft} dt$$

Discrete Fourier Transform is the Fourier Transform for time discrete values.

$$u(kT_s) \circ\!\!-\!\!\!-\!\!\bullet \underline{\tilde{U}}(\tfrac{n}{N \cdot T_s}) = \sum_{k=0}^{N-1} u(kT_s) \cdot \mathrm{e}^{-j2\pi n \frac{k}{N}}$$

with N: number of sampled values
and $n = 0, 1, 2, ..., N-1$.

Quantity of must-calculate-values: $\frac{N}{2} + 1$ (Fig. 2)

Solution vector for $N = 8$:

$$\underline{\tilde{U}}(\tfrac{n}{N \cdot T_s}) = \begin{bmatrix} \underline{\tilde{U}}(\frac{0}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{1}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{2}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{3}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{4}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{5}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{6}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{7}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{8}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{9}{N \cdot T_s}) \\ \vdots \end{bmatrix} = \begin{matrix} \text{just calculate} \\ \vdots \\ \vdots \\ \vdots \\ \vdots \\ \text{complex conjugated of } \underline{\tilde{U}}(\frac{3}{N \cdot T_s}) \\ \text{complex conjugated of } \underline{\tilde{U}}(\frac{2}{N \cdot T_s}) \\ \text{complex conjugated of } \underline{\tilde{U}}(\frac{1}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{0}{N \cdot T_s}) \\ \underline{\tilde{U}}(\frac{1}{N \cdot T_s}) \\ \vdots \end{matrix}$$

Here you have to calculate $\frac{8}{2} + 1 = 5$ values (namely $n = 0, 1, 2, 3, 4$). from who the other ones (namley $n = 5, 6, 7$) can be deduced. The N-th value is the same as $n = 0$ because of the periodic repitition.

Inverse discrete Fourier Transform calculates the values in time domain out of the DFT.

$u(kT_s) = \frac{1}{N} \sum_{n=0}^{N-1} \underline{\tilde{U}}(\frac{n}{N \cdot T_s}) \cdot \mathrm{e}^{j2\pi n \frac{k}{N}}$

with $k = 0, 1, 2, ..., N-1$.