Mini test regarding the lecture

„Circuit Analysis in Frequency and Time Domain“

Resources: script, calculator, mathematical formulary

Hints:

- Several answers are given to each question. *Only one* answer is correct.
- Make *only one* cross per problem.
- A problem is considered to be *properly* answered, if exactly one cross is placed at the right spot.
- If more than one cross is placed per problem, then the answer is considered as *wrong* and no points are given.
- Omitting a problem (no cross placed) yields no points as well.
- The achievable points for each problem are always indicated.
- Wrongly placed crosses do *not* result in penalty points.

(01) What is the correct expression to calculate the phase spectrum from a Fourier series?

A		$\varphi_n = -\arctan \frac{b_n}{a_n}$	**1 point**
B		$\varphi_n = -\arctan \frac{a_n}{b_n}$	
C		$\varphi_n = \arctan \frac{b_n}{a_n}$	
D		$\varphi_n = \arctan \frac{a_n}{b_n}$	
E		$\varphi_n = \arctan a_n - \arctan b_n$	

(02) A hidden half-wave symmetry in a time signal $f(t)$ is sometimes difficult to detect, if

A		the function $f(t)$ has zeros.	**1 point**
B		$f(t)$ has even symmetry as well.	
C		there is an additional steady component.	
D		$f(t)$ has odd symmetry as well.	
E		the function contains steps.	

(03) The Gibbs phenomenon occurs in connection with

A		a symmetrical triangular shaped function.	**1 point**
B		sharp bends (knees) in $f(t)$.	
C		curvature changes in $f(t)$.	
D		an unsymmetrical triangular shaped function.	
E		steps in $f(t)$.	

(04) At positive frequencies the phase spectrum of the complex Fourier series has

A		half the values of the phase spectrum of the real Fourier series.	**2 points**
B		values with different signs compared to phase spectrum of the real Fourier series	
C		always positive values.	
D		the same values as the phase spectrum of the real Fourier series.	
E		twice the values as the phase spectrum of the real Fourier series.	

(05) The ripple factor is

A		always greater than 1.	**2 points**
B		only usefully definable, if there is a steady component.	
C		always less than 1.	
D		always greater than the distortion factor.	
E		never negative.	

(06) What is the effective value of a sine-shaped voltage signal?

A		$U = \frac{\hat{u}}{\sqrt{2}}$	**1 point**
B		$U = \hat{u}\sqrt{2}$	
C		$U = \frac{\hat{u}}{\sqrt{3}}$	
D		$U = \hat{u}$	
E		$U = \hat{u}\sqrt{3}$	

(07) What is $e^{j n \pi/2}$ for $n = 3$?

A		j	**1 point**
B		$e^{j\pi/2}$	
C		$e^{-j\pi/2}$	
D		1	
E		$e^{j5\pi/2}$	

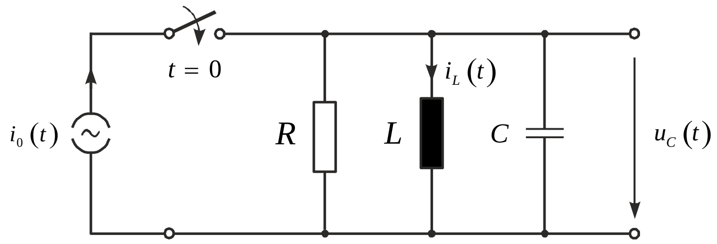
(08) Find the locations of the positive zeroes f_n of the function $\underline{F}(j\omega) = A\tau\,\mathrm{si}\left(\omega\tau/2\right)$ with $\omega = 2\pi f$ and $n = 1, 2, 3, \ldots$?

A		$f_n = 2n/\tau$	**2 points**
B		$f_n = (2n-1)/\tau$	
C		$f_n = 1/\tau$	
D		$f_n = n/\tau$	
E		$f_n = 2/\tau$	

(09) The Fourier series coefficients of a periodic triangular function have

A		a quadratic decline.	**1 point**
B		a linear decline.	
C		a cubic decline.	
D		no convergence.	
E		the same decline as the sawtooth function.	

(10) An alternating current source $i_0(t) = \hat{i}_0 \sin(\omega t)$ is connected via a switch to the following circuit. At the moment of $t = 0$, when the switch is closed, the network is free of energy. What is the Laplace transform $\underline{I}_L(p)$ for the coil current?

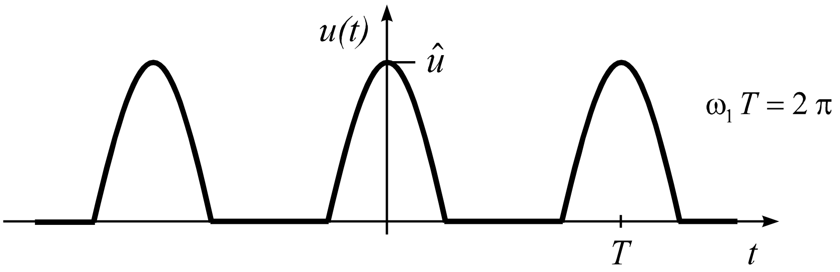


A		$\underline{I}_L(p) = \dfrac{\hat{i}_0\, p\, \omega_0^2}{(p^2 + 2\delta p + \omega_0^2)\cdot(p^2+\omega^2)}$	**4 points**
B		$\underline{I}_L(p) = \dfrac{\hat{i}_0\, \omega^2\, \omega_0^2}{p\cdot(p^2 + 2\delta p + \omega_0^2)\cdot(p^2+\omega^2)}$	
C		$\underline{I}_L(p) = \dfrac{\hat{i}_0\, p^2\, \omega}{(p^2 + 2\delta p + \omega_0^2)\cdot(p^2+\omega^2)}$	
D		$\underline{I}_L(p) = \dfrac{\hat{i}_0\, p\, \omega\, \omega_0}{(p^2 + 2\delta p + \omega_0^2)\cdot(p^2+\omega^2)}$	
E		$\underline{I}_L(p) = \dfrac{\hat{i}_0\, \omega\, \omega_0^2}{(p^2 + 2\delta p + \omega_0^2)\cdot(p^2+\omega^2)}$	

(11) The function $f(t) = \sin(\omega_1 t) + \sin(\sqrt{3}\,\omega_1 t)$

A		is periodic with $T = \dfrac{2\pi}{\sqrt{3}\,\omega_1}$.	**2 points**
B		is periodic with $T = \sqrt{3}\,\dfrac{2\pi}{\omega_1}$.	
C		is not periodic.	
D		is periodic with $T = \dfrac{2\pi}{\omega_1}$.	
E		has two different periods.	

(12) After a half-wave rectification of a periodic time function $\hat{u}\cos(\omega_1 t)$ the following periodic voltage $u(t)$ is obtained.



For the Fourier coefficients of the related Fourier series the following statement holds:

A		$a_n = 0$	**2 points**
B		$a_0 = 0$	
C		$a_{2n-1} = 0$	
D		$b_n = 0$	
E		$a_{2n} = 0$	

(13) The Fourier series of an average-free periodic rectangular function with even symmetry reads (provided the duty cycle is $\tau/T = 0,5$):

A		$f(t) = \sum_{n=1}^{\infty} a_{2n-1} \cos((2n-1)\,\omega_1 t)$	**2 points**
B		$f(t) = \sum_{n=1}^{\infty} a_{2n} \cos(2n\,\omega_1 t)$	
C		$f(t) = \sum_{n=1}^{\infty} a_n \cos(n\,\omega_1 t)$	
D		$f(t) = \sum_{n=1}^{\infty} b_{2n-1} \sin((2n-1)\,\omega_1 t)$	
E		$f(t) = \sum_{n=1}^{\infty} b_{2n} \sin(2n\,\omega_1 t)$	

(14) The Fourier series of a periodic sawtooth function converges

A		cubically.	**1 point**
B		linearly.	
C		quadratically.	
D		uniformly.	
E		frequency-dependent.	

(15) Which oft the following functions has the property $f(0)=1$?

A		$f(x)=\dfrac{x}{\sin x}$	**2 points**
B		$f(x)=\dfrac{x}{\cos x}$	
C		$f(x)=\dfrac{x}{\cos^2 x}$	
D		$f(x)=\dfrac{x^2}{\sin x}$	
E		$f(x)=\dfrac{x}{\sin^2 x}$	

(16) The function $f(t)=\tan(\omega_1 t)$

A		is limited.	**1 point**
B		contains a DC component.	
C		is not periodic.	
D		has a Fourier series with linear convergence.	
E		has no Fourier series.	

(17) Which symmetry has a function with the property $f(-t) = -f(t)$?

A		no symmetry	**1 point**
B		even symmetry	
C		half-wave symmetry	
D		odd symmetry	
E		full-wave symmetry	

(18) The Dirac impulse $\delta(t)$

A		is a function with odd symmetry.	**1 point**
B		is limited.	
C		is the neutral element of multiplication.	
D		does not at all come from Dirac.	
E		is the neutral element of convolution.	

Solutions

Answer	A	B	C	D	E	Points
Problem 01						/1
Problem 02						/1
Problem 03						/1
Problem 04						/2
Problem 05						/2
Problem 06						/1
Problem 07						/1
Problem 08						/2
Problem 09						/1
Problem 10						/4
Problem 11						/2
Problem 12						/2
Problem 13						/2
Problem 14						/1
Problem 15						/2
Problem 16						/1
Problem 17						/1
Problem 18						/1
Total						/28