Electrical Engineering Department

Signal Analysis (802321) – G1

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Second Term (1435-1436), Final Exam, Thursday 03/08/1436 H

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Q.1 Choose the correct answer:

From 1 – 17, 1.5 *Each, Total is* 25.5 | *From* 18 – 45, 1 *Each, Total is* 28 | *Total Grade is* 53.5

1.	The unit of the quantity ωt is:	
	a) Rad . s $^{-1}$	b) Hz . s $^{-1}$
	c) Rad	d) Hz . s
2.	A signal is a power signal if:	
	a) $0 < \int_{-\infty}^{\infty} \lvert g(t)\rvert^2 dt < \infty$	b) $0 \le \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} \lvert g(t)\rvert^2 dt < \infty$
	c) $\lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} \lvert g(t)\rvert^2 dt < \infty$	d) $0 < \lim_{T\to\infty} \frac{1}{T} \int_{-T/2}^{T/2} \lvert g(t)\rvert^2 dt < \infty$
3.	Calculating the power of any sinusoidal signal depends on:	
	a) The phase angle and frequency.	b) The maximum amplitude and phase angle.
	c) The maximum amplitude only.	d) The maximum amplitude and frequency.
4.	Given the signal $x(t) = C_1 \cos \omega_1 t + C_2 \cos \omega_2 t + C_3 \cos \omega_3 t$. The power of $x(t)$ is calculated as:	
	a) ½ $[C_1^2 + C_2^2 + C_3^2]$	b) ½ $[C_1 + C_2 + C_3]$
	c) ½ $[C_1 + C_2 + C_3]^2$	d) $[C_1^2 + C_2^2 + C_3^2]$
5.	If a signal is time-shifted, scaled and inverted, which order can be followed?	
	a) Scaling → shifting → inversion.	b) Shifting → inversion → scaling.
	c) Inversion → shifting → scaling.	d) All the above.
6.	Discrete-time signal is a signal that is:	
	a) Specified for all values of amplitude.	b) Specified for all values of time.
	c) Specified for some values of amplitude.	d) Specified for some values of time.
7.	The energy and power of the periodic complex exponential signal $e^{j\omega_0 t}$ are:	
	a) Energy is ∞, power is 1.	b) Energy is ∞, power is T_0.
	c) Energy is T_0, power is 1.	d) Energy is ω_0, power is 1.
8.	The frequencies of a set of harmonically-related complex exponential signals, with the fundamental frequency 100π (rad/s), can be:	
	a) 100π, 150π, 350π, and 550π.	b) 100π, 150π, 200π, and 250π.
	c) 100π, 300π, 500π, and 700π.	d) 100π, 50π, 200π, and 300π.

9.	Which one of the following signals is complex?	
	a) $\left|7e^{-j5000\pi t}\right|$	b) $j^2\left(\frac{1}{j}t + jt^2\right)$
	c) $\frac{1}{j2}\left[e^{j50\pi t} - e^{-j50\pi t}\right]$	d) $\frac{1}{2}\left[e^{j50\pi t} + e^{-j50\pi t}\right]$
10.	In non-memoryless (dynamic) systems, the output at any instant depends on input values at:	
	a) The same or past time.	b) The same and (past and / or future) time.
	c) The same time only.	d) The same and past time only.
11.	Which one of the following systems is nonlinear:	
	a) $y[n] = n\,x[n]$	b) $y(t) = ½\,x(t)$
	c) $y(t) = 2\,x(t) + 1.5$	d) $y(t) = 2\,t\,x(t)$
12.	Fourier series is expressed using the formula $x(t) = a_o + 2\sum_{k=1}^{\infty}\frac{a_{-k}}{j}\sin k\omega_0 t$, when:	
	a) $x(t)$ is complex but $\{a_k\}$ are imaginary	b) $x(t)$ is real but $\{a_k\}$ are complex
	c) $x(t)$ is real but $\{a_k\}$ are imaginary	d) $x(t)$ is complex but $\{a_k\}$ are real
13.	Given a square wave with the following characteristics: $x(t) = \begin{cases} 1 & , \quad \|t\| \le 1 \\ 0 & , \quad 1 \le \|t\| \le 2 \end{cases}$	
	a) $T_1 = 1$, $T = 2$	b) $T_1 = ½$, $T = 2$
	c) $T_1 = 1$, $T = 4$	d) $T_1 = ½$, $T = 4$
14.	Given that the signal $x(t)$ in Q.13 has the Fourier series coefficients a_k , if $x(t)$ is time-expanded by 2, then the new Fourier series coefficients d_k will be:	
	a) $d_k = a_k$, and ω_0 is divided by 2	b) $d_k = a_k$, but ω_0 is doubled
	c) $d_k = a_k / 2$, but ω_0 remains the same	d) $d_k = a_k / 2$, and ω_0 is doubled
15.	The Fourier transform of the signal $x(t) = e^{3t}\,u(-t)$ is:	
	a) $X(j\omega) = \frac{1}{3+j\omega}$	b) $X(j\omega) = \frac{1}{3-j\omega}$
	c) $X(j\omega) = \frac{6}{9+\omega^2}$	d) $X(j\omega) = \frac{3}{9+\omega^2}$
16.	Which function can be the Fourier transform of a periodic signal $x(t)$?	
	a) $X(j\omega) = \frac{1}{2}\sum_{k=-\infty}^{\infty}\delta(\omega - k\omega_0)$	b) $X(j\omega) = \frac{1}{2}\sum_{k=-\infty}^{\infty}\text{sinc}(\omega - k\omega_0)$
	c) $X(j\omega) = \frac{1}{2}\sum_{k=-\infty}^{\infty}u(\omega - k\omega_0)$	d) $X(j\omega) = \sum_{k=-\infty}^{\infty}\frac{\sin k\omega_0}{k}\delta(\omega - \omega_0)$
17.	Inverse Fourier transform is calculated as:	
	a) $x(t) = \int_{-\infty}^{\infty} X(f)e^{j2\pi ft}df$	b) $x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(f)e^{j2\pi ft}df$
	c) $x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(j\omega)e^{-j\omega t}d\omega$	d) $x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(j\omega)e^{j\omega t}dt$

18.	Which one of the following signals has both even and odd parts (that are not equal to zero)?	
	a) $\cot \omega_0 t$	b) t^{-2}
	c) $\sin \omega_0 t$	d) e^{2t}
19.	The noise signal is classified as:	
	a) Power and random signal.	b) Energy and random signal.
	c) Power and deterministic signal.	d) Energy and deterministic signal.
20.	Given an exponential signal $x(t)$. If the exponent equals $j2000\pi t$, the fundamental frequency and period-energy equal:	
	a) $f_0 = 1000$ Hz, $E_{x\,period} = \infty$.	b) $f_0 = 2000\pi$ Hz, $E_{x\,period} = \infty$.
	c) $f_0 = 1000$ Hz, $E_{x\,period} = 1$ m.	d) $f_0 = 2000\pi$ Hz, $E_{x\,period} = 1$ m.
21.	Which statement is correct?	
	a) $\delta(t)$ is undefined at $t = 0$	b) $\delta[n]$ is undefined at $n = 0$
	c) $\delta(t) = 1$ at $t = 0$	d) $\delta[n] = 1$ for all real values of n
22.	The running sum of the function $x[n]$ is:	
	a) $\sum_{m=-\infty}^{n} x[m]$	b) $\sum_{m=0}^{n} x[m]$
	c) $\sum_{m=-\infty}^{\infty} x[m]$	d) $\sum_{m=1}^{\infty} x[m]$
23.	Which one of the following systems is causal?	
	a) $x(t) = \sum_{n=-\infty}^{0} x(n)$	b) $x(t) = \sum_{n=-\infty}^{t+1} x(n)$
	c) $x(t) = \sum_{n=t}^{\infty} x(n)$	d) $x(t) = \sum_{n=-\infty}^{t} x(n)$
24.	The system $y(t) = x(4 - 2t)$ is:	
	a) Nonlinear and time-invariant	b) Linear and time-invariant
	c) Nonlinear and time-variant	d) Linear and time-variant
25.	For the periodic signal: $x(t) = \cos\left(\frac{\pi}{t}\right)$ for $0 < t \leq 2$:	
	a) $\omega_0 = \pi$, and $\{a_k\}$ are invalid.	b) $\omega_0 = \pi$, and $\{a_k\}$ are valid.
	c) $\omega_0 = \frac{\pi}{t^2}$, and $\{a_k\}$ are invalid.	d) $\omega_0 = \frac{\pi}{t}$, and $\{a_k\}$ are invalid.
26.	Given the signal: $x(t) = 1 + \cos\frac{16\pi}{3}t + \frac{1}{2}\cos 4\pi t - \sin\frac{4\pi}{3}t$. The fundamental period of $x(t)$ is:	
	a) $T = 0.5$	b) $T = 0.4$
	c) $T = 1.5$	d) None of the above.

27.	In the signal $x(t)$ given in Q.26, the harmonics which exist are:	
	a) 1st, 2nd and 3rd.	b) 1st, 2nd and 4th.
	c) 2nd, 3rd and 4th.	**d) 1st, 3rd and 4th.**
28.	A periodic signal is given by: $x(t) = 2 + \cos\left(\frac{4\pi}{3}t\right) + \frac{1}{2}\cos\left(\frac{10\pi}{3}t\right)$ The fundamental frequency of $x(t)$ is:	
	a) $\omega_0 = 4\pi/3$	**b) $\omega_0 = 2\pi/3$**
	c) $\omega_0 = \pi/3$	d) $\omega_0 = 3\pi/2$
29.	The Fourier series coefficients a_k of the signal $x(t)$ given in Q.28 are:	
	a) $a_0 = 2,\ a_2 = a_{-2} = 0.5,\ a_5 = a_{-5} = 0.25$	b) $a_0 = 2,\ a_1 = a_{-1} = 0.5,\ a_5 = a_{-5} = 0.25$
	c) $a_0 = 2,\ a_2 = a_{-2} = 1,\ a_5 = a_{-5} = 0.5$	d) $a_0 = 2,\ a_2 = a_{-2} = 0.5,\ a_{10} = a_{-10} = 0.25$
30.	Fourier series can be used to represent:	
	a) All periodic signals.	**b) Almost all periodic signals.**
	c) Large set of periodic signals.	d) Some periodic signals.
31.	Given the signal $x(t) = \cos^2 3\pi t$. If the fundamental frequency in radian per second is 3π:	
	a) $a_0 = ½$, $a_1 = 0$, $a_2 = ½$	b) $a_0 = ½$, $a_1 = ¼$, $a_2 = 0$
	c) $a_0 = 0$, $a_1 = ¼$, $a_2 = 0$	**d) $a_0 = ½$, $a_1 = 0$, $a_2 = ¼$**
32.	For the signal $x(t)$ given in Q.13 (the square wave):	
	a) $a_0 = ½$, $a_k = (1/k\pi) \sin (k\pi/2)$ for $k \neq 0$	b) $a_0 = 1$, $a_k = (1/k\pi) \sin (k\pi/2)$ for $k \neq 0$
	c) $a_0 = ½$, $a_k = (1/k\pi) \sin (k\pi)$ for $k \neq 0$	d) $a_0 = 1$, $a_k = (1/k\pi) \sin (k\pi)$ for $k \neq 0$
33.	If the signal $x(t)$ given in Q.13 is shifted up by ¼ , then the new Fourier series coefficients b_k will be:	
	a) $b_k = a_k + ¼$, for $k = 0$	b) $b_k = a_k + ¼$, for all values of k
	c) $b_k = a_k$ but frequency is shifted by ¼	d) $b_k = a_k - ¼$, for $k = 0$
34.	If the signal $x(t)$ given in Q.13 is time-reversed, then the new Fourier series coefficients c_k will be:	
	a) $c_0 = a_0$, $c_k = a_{-k} = -a_k$	**b) $c_0 = a_0$, $c_k = a_{-k} = a_k$**
	c) $c_0 = -a_0$, $c_k = a_{-k} = a_k$	d) $c_0 = -a_0$, $c_k = a_{-k} \neq -a_k$
35.	If the signal $x(t)$ given in Q.13 is shifted to the left by ½ , then the new Fourier series coefficients e_k will be:	
	a) $e_0 = a_0$, $e_k = a_k\ e^{-jk(\pi/4)}$ for $k \neq 0$	b) $e_0 = a_0$, $e_k = a_k\ e^{-jk(\pi/2)}$ for $k \neq 0$
	c) $e_0 = a_0$, $e_k = a_k\ e^{jk(\pi/4)}$ for $k \neq 0$	d) $e_0 = 0$, $e_k = a_k\ e^{-jk(\pi/4)}$ for $k \neq 0$
36.	If a_k are the Fourier series coefficients of a signal $g(t)$, the Fourier series coefficients of the signal $dx(t)/dt$ are:	
	a) $(1/jk\omega_0)\ a_k$	**b) $jk\omega_0\ a_k$**
	c) $(-1/jk\omega_0)\ a_k$	d) $-jk\omega_0\ a_k$

37.	For which signal do we have to sketch the magnitude and phase of its Fourier transform?	
	a) $x(t) = e^{-12\|t\|}$	b) $x(t) = 5\,\mathrm{rect}(2t)$
	c) $x(t) = \cos 200\pi t$	d) $1/3\,u(t)$
38.	The Fourier transform of the signal $x(t) = e^{-at}u(t)$ equals to:	
	a) $F\{e^{-a\|t\|} - e^{at}u(-t)\}$	b) $F\{e^{-a\|t\|}\} - F\{e^{at}u(-t)\}$
	c) $F\{e^{at}u(-t)\} - F\{e^{-a\|t\|}\}$	d) $F\{e^{-a\|t\|}\} + F\{e^{at}u(-t)\}$
39.	The function $X(j\omega) = \mathrm{sinc}(3.5\omega)$ is the Fourier transform of the signal:	
	a) $x(t) = \frac{1}{7}\,\mathrm{rect}\left(\frac{t}{7}\right)$	b) $x(t) = \frac{1}{3.5}\,\mathrm{rect}\left(\frac{t}{3.5}\right)$
	c) $x(t) = 7\,\mathrm{rect}\left(\frac{t}{7}\right)$	d) $x(t) = 3.5\,\mathrm{rect}\left(\frac{t}{3.5}\right)$
40.	The function $X(j\omega) = \pi e^{\|\omega\|}$ is the Fourier transform of the signal:	
	a) $x(t) = \frac{2}{1+t^2}$	b) $x(t) = \frac{1}{t^2+1}$
	c) $x(t) = \frac{1}{t^2-1}$	d) None of the above
41.	Given the energy apriodic signal $x(t) = t$, for $-1 \le t \le 1$. If $y(t) = \frac{dx(t)}{dt}$, then $y(t)$ equals:	
	a) $y(t) = \mathrm{rect}\left(\frac{t}{2}\right) - \delta(t+1) + \delta(t-1)$	b) $y(t) = \mathrm{rect}\left(\frac{t}{2}\right) - \delta(t+1) - \delta(t-1)$
	c) $y(t) = \mathrm{rect}\left(\frac{t}{2}\right) + \delta(t+1) + \delta(t-1)$	d) $y(t) = \mathrm{rect}\left(\frac{t}{2}\right)$
42.	Using the integration property to find the Fourier transform of $x(t)$ in Q.41:	
	a) $X(j\omega) = \frac{1}{j\omega}Y(j\omega) + \pi\,Y(0)\,\delta(\omega)$	b) $X(j\omega) = \frac{1}{j\omega}Y(j\omega) + \pi\,X(0)\,\delta(\omega)$
	c) $X(j\omega) = \frac{1}{j\omega}Y(j\omega)$	d) $X(j\omega) = \frac{1}{j\omega}Y(j\omega) + \pi\,\delta(\omega)$
43.	The signum function $\mathrm{sgn}(t)$ can be defined as:	
	a) $\mathrm{sgn}(t) = u(t) + u(-t)$	b) $\mathrm{sgn}(t) = 1 - 2u(t)$
	c) $\mathrm{sgn}(t) = u(t) - u(-t)$	d) b) and c)
44.	The Fourier transform of the function $\mathrm{sgn}(t)$ is:	
	a) $1/j\omega$	b) $2/j\omega + 2\pi\,\delta(\omega) - 1$
	c) $2/j\omega$	d) $2/j\omega - \pi\,\delta(\omega)$
45.	What is the Fourier transform of the triangular function $\Delta\left(\frac{t}{\tau}\right)$. Note that this is a single triangular pulse with amplitude 1 and width τ.	
	a) $\delta(\omega - \frac{2\pi}{\tau})$	b) $\frac{\tau}{2}\,\mathrm{sinc}\left(\frac{\omega\tau}{4}\right)$
	c) $\Delta\left(\frac{\omega\tau}{2}\right)$	d) $\frac{\tau}{2}\,\mathrm{sinc}^2\left(\frac{\omega\tau}{4}\right)$