University of California, San Diego
Department of Electrical and Computer Engineering

ECE45 - Winter 2020
Final Exam

Tuesday, March 17, 2020 3:00pm to 6:00pm
Location: On-line

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Problem 01:

The convolution $\delta(t-1) * \delta(t+2) * u(t+1) * \delta(t-3) * \delta(t)$ equals
$u(t-1)$
$u(t+1)$
$u(t)$
$\delta(t-1)$
$\delta(t+1)$
$\delta(t)$
$\delta(t-2) + u(t+1)$

Problem 02:

The value of the Fourier transform of $u(t-1)-u(t-8)$ at $\omega = 0$ is
7
6
8
9
14π
18π
$7/(2\pi)$
$4/\pi$

Problem 03:

If a linear, time-invariant system with impulse response $e^{-t}u(t-1)$ has input $\delta(t-2)$, what is the output at $t = 4$?

$1/e^2$
$1/e$
e
e^2
$1/e^3$
$1/e^4$
e^3
3^4
0

Problem 04:

The Fourier transform of $\delta(t-1)\cos(\pi t)$ is
$-1/e^{j\omega}$
$1/e^{j\omega}$
$e^{j\omega}$
$-e^{j\omega}$
$(1/2)\delta(\omega-1)+(1/2)\delta(\omega+1)$
$(1/2)\delta(\omega-\pi)+(1/2)\delta(\omega+\pi)$

Problem 05:

The signal $x(t)$ is causal and its bilateral Laplace transform is $\frac{1}{(2s+1)(s+1)}$. The value of $x(t)$ at time $t = 2$ is:

$\frac{e-1}{e^2}$

$\frac{1-e}{e^2}$

$\frac{1}{e}$

$\frac{-1}{e}$

$\frac{1}{e^2}$

e^2

$e - e^2$

$e^2 - e$

$(2e + 1)(e + 1)$

$\frac{1}{(2e+1)(e+1)}$

Problem 06:

The function $f(t) = |\cos(2t/\pi)|$ has period:
$\pi^2/2$
2π
π
$\pi/2$
$2/\pi^2$
$1/\pi$
4π
$\pi/4$
1
$1/2$

Problem 07:

If $x(t)$ and $y(t)$ are each periodic with period two, then $x(t) + y(t)$ must:

None of These.
be periodic with period one-half.
be periodic with period one.
be periodic with period two.
be periodic with period four.

Problem 08:

The Fourier transform of $x(t) = j\sin(\sin(\cos(\sin 4t)))$ is

imaginary and even
imaginary and odd
real and even
real and odd
None of These

Problem 09:

What is the magnitude of the impedance of a capacitor at frequency 10 kHz if the capacitance is 10 micro-farads ?
$5/\pi$
$\pi/5$
$-5j/\pi$
$5j\pi$
10
$-10j$
$10j$
5
$-5/\pi$
None of These

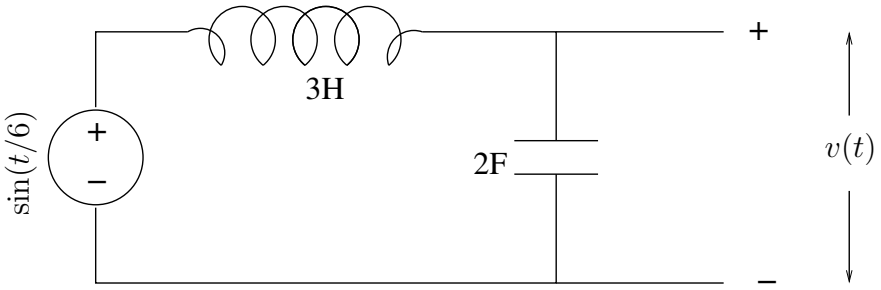
Problem 10:

If a resistor of resistance $R = 10$ Ohms, a capacitor of capacitance $C = 5$ Farads, and an inductor of inductance $L = 2$ Henrys, are all in series, what is the real part of the impedance of the series combination ?

10
17
1
5
$1/10$
$1/5$
$1/2$
$2/5$
$5/2$
None of These

Problem 11:

The circuit shown is in steady state and has one capacitor and one inductor and one voltage source. What is the phasor of the voltage $v(t)$?



$-(6/5)j$
$-(5/6)j$
$(5/6)j$
$(6/5)j$
$2/5$
$-(2/5)j$
$j/5$
$-j/5$
$1/2$
None of these

Problem 12:

The signal

$$x(t) = \begin{cases} 2\sin(3t) \cdot \frac{\cos(5t)}{t} & \text{if } t \neq 0 \\ 35 & \text{if } t = 0 \end{cases}$$

is:

an even function.
an odd function.
neither an even nor odd function.

Problem 13:

The signal

$$y(t) = \begin{cases} \frac{\sin(t)}{t} & \text{if } t \neq 0 \\ 1 & \text{if } t = 0 \end{cases}$$

is:

not periodic.
periodic with period 2π.
periodic with period π.
periodic with period $\pi/2$.
periodic with period 1.
periodic with period 2.
periodic with period $1/\pi$.
periodic with period $1/(2\pi)$.

Problem 14:

The signal $x(t) = \cos(3t) + \sin(7t)$ is:

periodic and bandlimited.
periodic and not bandlimited.
bandlimited and not periodic.
not bandlimited and not periodic.

Problem 15:

The signal $x(t) = 3 \cdot \text{rect}(2t)$ is:

not bandlimited and not periodic.
periodic and bandlimited.
periodic and not bandlimited.
bandlimited and not periodic.

Problem 16:

If the signal $x(t) = (2/t^2)\sin^2(9t)$ is defined to be continuous at $t = 0$, then it is:

bandlimited and even.
even and not bandlimited.
bandlimited and not even.
not even and not bandlimited.

Problem 17:

At $\omega = 0$, the Fourier transform, $X(\omega)$, of $x(t) = e^{-|3t|}$ equals:

$2/3$
2
$1/3$
0
$3/2$
3
None of these.

Problem 18:

The number of delta functions in the convolution of the signal
$x(t) = 3\delta(t-1) + 2\delta(t) + \delta(t+1)$ with itself is:

5
1
2
3
4
6
None of these.

Problem 19:

The signal $y(t) = e^{3jt} + e^{\pi jt}$ is:

not periodic.
periodic with period 1.
periodic with period 2π.
periodic with period $2\pi/3$.
periodic with period π.
periodic with period $1/2$.
periodic with period $\pi/3$.

Problem 20:

If the Fourier transform of the signal $x(t) = \cos(2\pi t)(u(t-4) - u(t-5))$ is $X(\omega)$, then the value of $\int_{-\infty}^{\infty} |X(\omega)|^2 d\omega$ is:

π
1
2π
$\pi/2$
2
0
None of these.

Problem 21:

The convolution of $x(t) = u(t-4)$ with $y(t) = -u(t+4)$, at $t = 1$ is:
-1
-2
0
1
2
3
None of these.

Problem 22:

What is the convolution of $\delta(t) - 2\delta(t+2)$ and $\mathrm{rect}\,(2t)$ at $t = 1$?
None of these.
1
-2
-1
3
4
5
-3
2

Problem 23:

If $p(t) = \sum_{n=-\infty}^{\infty} \delta(t - n\pi)$. then $\int_{-1}^{3} P(\omega) d\omega$ equals

4
3
2
1
0
π
5
4π
∞
None of these.

Problem 24:

Let $x(t) = 2\pi\cos(5t)$, and $H(\omega) = \text{rect}\,(\omega)$. If $P(\omega) = \sum_{n=-\infty}^{\infty} \delta(\omega - 5n)$, what is the output (in the time domain) of an LTI system with frequency reponse $H(\omega)$ to input $x(t)p(t)$?

1
2
$\delta(t)$
$2\pi\delta(t)$
$\cos(5t)$
$2\cos(5t)$
$2\pi\cos(5t)$
0
$1/2$
π
$1/\pi$
None of these.

Problem 25:

Let $X(\omega) = 6$ when $70 \leq |\omega| \leq 90$, and let $X(\omega) = 0$ otherwise. Let $y(t) = x(t)\cos(30t)$. What is $Y(42)$?
3
6
12
3π
6π
12π
0
70
90
None of these.

Problem 26:

If the inverse bilateral Laplace transform of $X(s) = \frac{2}{s-3+4j}$ exists at $s = (1/3) + 2j$, then what is $x(2)$?

0

$e^{-2(3-4j)}$

$e^{-2(3+4j)}$

$-e^{-2(3-4j)}$

$-e^{-2(3+4j)}$

$e^{2(3-4j)}$

$e^{2(3+4j)}$

$-e^{2(3-4j)}$

$-e^{2(3+4j)}$

None of these

Problem 27:

Let $p_1(t) = \sum_{n=-\infty}^{\infty} \delta\left(t - \frac{\pi}{2}n\right)$ and $p_2(t) = \sum_{n=-\infty}^{\infty} \delta\left(t - \frac{\pi}{2}n + \frac{\pi}{4}\right)$.
If $x(t) = 3\text{sinc}\,(3t)\,(p_1(t) + p_2(t))$, then what is $X(\omega)$ when $\omega = 4$??
0
4
$2/3$
1
$1/6$
8
2
3
6
∞
None of these

Problem 28:

Let $x(t) = \sin(10t)$ and $H(\omega) = 2\text{rect}\left(\frac{\omega}{30}\right)$. Then if $x(t)\cos(20t)$ is the input to an LTI system with frequency response $H(\omega)$, what is the output of the system in terms of $x(t)$?
$-x(t)$
$x(t)$
$x(t)/2$
$-x(t)/2$
$2x(t)$
$-2x(t)$
$x^2(t)$
$x(t-10)$
$x(t-20)$
$x(t)+1$
None of these

Problem 29:

If $\int_{-\infty}^{\infty} |F(\omega)|^2 d\omega = 5\pi$, and $g(t) = 2f(t-4)e^{3jt}$, then what is $\int_{-\infty}^{\infty} |g(t)|^2 dt$?
10
20
5
2
5π
2π
10π
$2/pi$
$5/pi$
$1/(2\pi)$
None of these

Problem 30:

What is the causal inverse bilateral Laplace transform of $\frac{18s}{9s^2+\pi^2}$ evaluated at $t = 6$?
2
1
0
-1
-2
$1/2$
$-1/2$
$\sqrt{3}$
$\sqrt{3}/2$
None of these

Problem 31:

What is the Nyquist frequency of $\cos^3(2t)$ in radians per second, where

$$t$$

is measured in seconds?
12
6
3
2
1
24
12π
6π
3π
2π
None of these.

Problem 32:

If

$$x(t) = \begin{cases} A & \text{if } 0 < t < A \\ -A & \text{if } -A < t < 0 \\ 0 & \text{else} \end{cases}$$

then its Fourier transform $X(\omega)$ equals

$\frac{2A(1-\cos(\omega A))}{j\omega}$

$-\frac{2(1-\cos(\omega A))}{j\omega}$

$\frac{1-\cos(\omega A)}{j\omega}$

$-\frac{1-\cos(\omega A)}{j\omega}$

$\frac{2(1-\sin(\omega A))}{\omega}$

$-\frac{2(1-\sin(\omega A))}{\omega}$

$\frac{\sin(\omega A)}{\omega}$

$2\frac{\sin(\omega A)}{\omega}$

$\frac{\sin(\omega A)}{A\omega}$

None of these.

Problem 33:

If $x(t) = h(t) = 2e^{-5t}u(t)$, where $x(t)$ is the input to a linear, time-invariant system with impulse response $h(t)$, then the output of the system at $t = 3$ is:
$12/e^{15}$
$3/e^{15}$
$6/e^{15}$
$12/e^{5}$
$3/e^{5}$
$6/e^{5}$
$1/e^{15}$
$1/e^{5}$
$1/5e^{15}$
None of these.

Problem 34:

Suppose the input $x(t)$ and output $y(t)$ of an LTI system always satisfy the differential equation

$$\frac{dy(t)}{dt} = \frac{dx(t)}{dt} + 4x(t).$$

Then the magnitude of the frequency response of the system at $\omega = 2$ is:
$\sqrt{5}$
5
4
2
$\sqrt{17}$
17
16
3
0
None of these.

Problem 35:

Suppose $x(t)$ is a periodic signal with period 1 and $x(t) = e^{-t}$ when $0 < y \leq 1$. Then the coefficient F_n of the nth term of the exponential form of the Fourier Series for $x(t)$ is

$\frac{1-e^{-1}}{1+2\pi jn}$

$-\frac{1-e^{-1}}{1+2\pi jn}$

$\frac{1+e^{-1}}{1+2\pi jn}$

$-\frac{1+e^{-1}}{1+2\pi jn}$

$\frac{1-e}{1+2\pi jn}$

$\frac{1+e}{1+2\pi jn}$

$\frac{1-e^{-1}}{1-2\pi jn}$

None of these.

Problem 36:

Suppose an circuit consisting of resistors, capacitors, and inductors is in sinusoidal steady state. One particular subcircuit has one wire in and one wire out of it and the phasor current running through that wire is $4+3j$ and the corresponding phasor voltage across the wire is $5+6j$. What is the average power through that subcircuit?

19

1

38

2

20

18

None of these.