Marks Scored:

KATHMANDU UNIVERSITY
End Semester Examination [C]
June, 2018

Level : B. E.
Year : III
Course : EEEG 313
Semester : I

Exam Roll No. :
Time: 30 mins.
F. M. : 20

Registration No.:
Date : JUN 18 2018

SECTION "A"
[20 Q. × 1 = 20 marks]

1) The frequency components present in the signal $x(t) = 2sin^2t + \cos 2t$ are:
a) $\frac{1}{\pi}$ and $\frac{1}{2\pi}$ Hz
b) $\frac{1}{\pi}$ and 0 Hz
c) $\frac{1}{2\pi}$ and 0 Hz
d) $\frac{1}{2\pi}$ Hz only

2) Using the property of the impulse function, the integral $\int_{-1}^{1} e^{-2t}\delta(t)dt$ results:
a) 0
b) $\frac{e^2-e^{-2}}{2}$
c) 1
d) $\frac{e^{-2}-e^2}{2}$

3) For a periodic continuous time signal with fundamental period T, which is true?
a) T must be a positive constant
b) T must be a constant either positive or negative
c) T must be a positive integer
d) T must be an integer either positive or negative

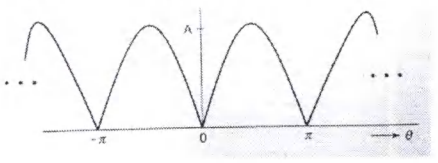
4) For the signal $x(t) = t^2 + 2t$, the even part is……
a) $x_e(t) = 2t$
b) $x_e(t) = t^2 + 2$
c) $x_e(t) = t^2$
d) $x(t)$ itself

5) If the signal $x(t)$ has total time duration of T s, the duration of the signal $x\left(\frac{t}{2} - 1\right)$
a) T s
b) $\frac{T}{2} - 1$ s
c) $2T - 1$ s
d) $2T$ s

6) The average power of a periodic exponential signal $x(t) = a_n e^{jn\omega_0 t}$ with fundamental frequency $\omega_0$is…..
a) $|a_n|^2$
b) $|a_n|$
c) $|a_n|$
d) ${a_n}^2 e^{j2n\omega_0 t}$ s

7) IF the signal $x(t)$is real, then its FS coefficients satisfy……..
a) $a_{-k} = a_k$
b) $a_{-k} = -a_k^*$
c) $a_{-k} = -a_k$
d) $a_{-k} = a_k^*$

8) The dc component (a_0) of the periodic sinusoidal function shown below is:



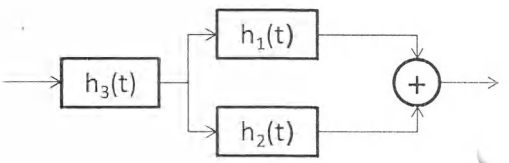
a) $\frac{2A}{\pi}$
b) $\frac{A}{\pi}$
c) $\frac{A}{2\pi}$
d) $\frac{4A}{\pi}$

9) The Fourier transform of $x(t) = e^{at}u(-t)$ is:
a) $\frac{1}{a+j\omega}$
b) $\frac{1}{a-j\omega}$
c) $\frac{1}{j\omega-a}$
d) $\frac{-1}{a+j\omega}$

10) Shifting a time signal along the time axis causes.....
a) a change in magnitude spectrum only
b) a change in phase spectrum only
c) a change in both amplitude and phase spectrum
d) no change in either magnitude or phase spectrum

11) An LTI system is stable if,
a) $\sum_{k=-\infty}^{\infty}|h[k]| \leq \infty$ b) $\sum_{k=0}^{\infty}|h[k]| \leq \infty$
c) $\sum_{k=-\infty}^{\infty}|h[k]| < \infty$ d) $\sum_{k=0}^{\infty}|h[k]| < \infty$

12) If $h_1(t)$, $h_2(t)$, and $h_3(t)$ are impulse responses of the individual sub systems, the net impulse response of the system shown below is....
a) $h(t) = h_3(t)h_1(t) + h_3(t)h_2(t)$
b) $h(t) = {}_1(t) + h_2(t) + h_3(t)$
c) $h(t) = h_3(t) + [h_1(t) * h_2(t)]$
d) $h(t) = h_3(t) * h_1(t) + h_3(t) * h_2(t)$



13) An LTI system has impulse response $h[n] = 5\delta[n-2]$. Which is TRUE about the system?
a) It just amplifies the input b) It just delays the input
c) It amplifies and delays the input d) It samples the input

14) The impulse response of a first order reconstruction system is.....
a) a sinc function b) a rectangular function
c) a gaussian function d) a triangular function

15) A band limited lowpass signal is sampled at twice its Nyquist rate with $f_s = 2000$ samples per second. The signal is bandlimited to.....
a) 500 Hz b) 250 Hz c) 1000 Hz d) 2000 Hz

16) The DTFS differs from CTFS in the manner that.....
a) DTFS continuous spectra b) DTFS is a periodic spectra
c) DTFS has constant spectra d) DTFS is infinite spectra

17) White noise is characterized by.....
a) exponential PSD b) Gaussian PSD
c) constant PSD d) zero PSD

18) Which of the following statement is true?
a) All causal systems are memory less b) All memory less systems are causal
c) All causal and linear systems are stable d) All memory less systems are invertible

19) Which of following represents impulse response of a finite impulse response (FIR) system?
a) $h[n] = u[n]$ b) $h[n] = 0.5^n u[n]$
c) $h[n] = 2^n u[n]$ d) $h[n] = \delta[n]$

20) Convolution of $x(t+6)$ with $\delta(t-4)$gives .....
a) $x(t+2)$ b) $x(t+10)$
c) $x(t-10)$ d) $x(t-2)$

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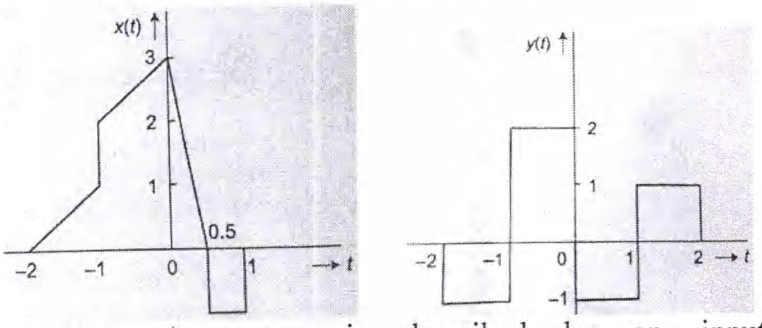
SECTION "B"
[5Q × 11 = 55 marks]

Attempt *ANY FIVE* questions. Assume suitably for any missing information.

1. a. What do you understand by dimension of a signal? Explain one dimensional and multi dimensional signals with proper examples. [2]

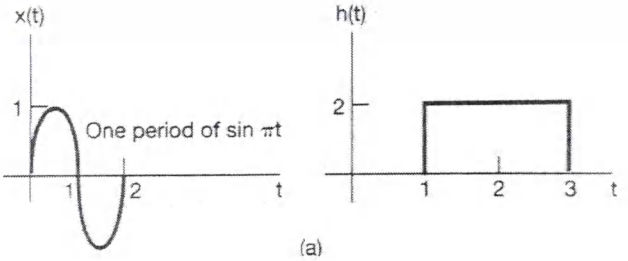
b. Signals $x(t)$ and $y(t)$ are shown in figures below. Find and plot: [4]

i) $x(-t+2)$
ii) $y(2t-3)$
ii) $x(t)y(t)$
iii) $\frac{d}{dt}x(t)$



c. Define a linear system. A system is described by an input output relationship $2\frac{d}{dt}y(t) = x(t)$, where, $x(t)$ and $y(t)$ are inputs and outputs of the system. Is the system linear? [2]

d. Find the convolution between the CT signals shown below. Use the graphical fold and shift method and show all necessary intermediate figures. [3]



(a)

2. a. Convolution between two DT functions $x[n]$ and $y[n]$ is defined as a sum given by: [4]

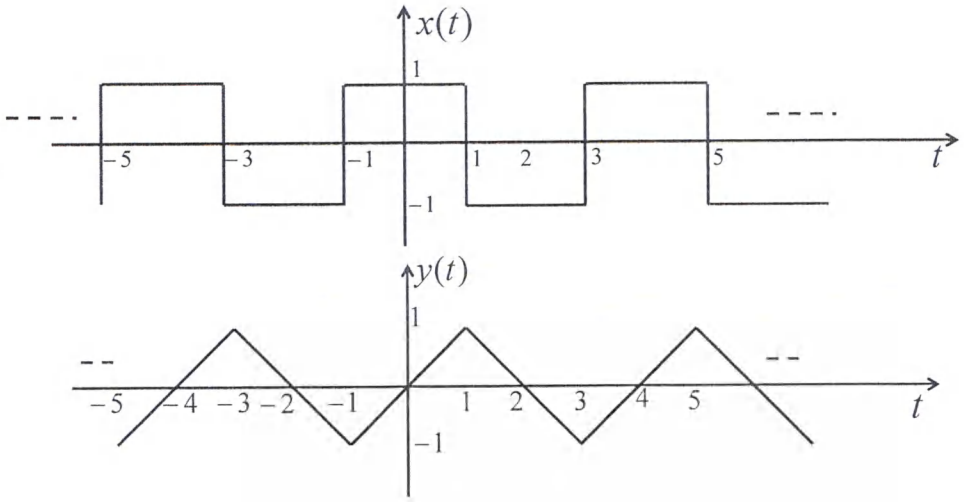
$$z[n] = \sum_{k=-\infty}^{\infty} x[k]y[n-k]$$

State and prove commutative, distributive and associative properties of convolution sum.

b. Determine if the LTI systems with following impulse responses are causal and/or stable. Justify your answers. [3]

i) $h[n] = \left(\frac{1}{5}\right)^n u[n]$
ii) $h(t) = e^{-6t}u(3-t)$

c. Two signal $x(t)$ and $y(t)$ are shown in figures. What is the relation between them? The FS coefficients of $x(t)$ are given as: $a_k = \begin{cases} 0, & for\ k = 0 \\ 2\frac{sin(\pi k/2)}{k\pi}, & for\ k \neq 0 \end{cases}$. Using the suitable properties of the Fourier Series, find the FS coefficients of $y(t)$.



3. a. A periodic square wave has its one period defined as: [4]

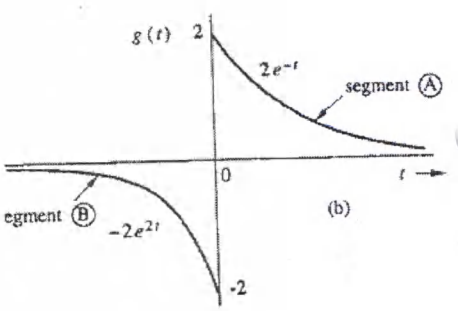
$$x(t) = \begin{cases} 1, & for\ |t| < 1 \\ 0, & for\ 1 < |t| < 3 \end{cases}$$

Sketch the signal $x(t)$ and using the definition of exponential Fourier series, compute the FS coefficients. Is it possible to express the FS coefficients as a sinc function?

b. When a signal is expresses as a linear combination of harmonically related DT complex exponentials, it is called the DTFS. Derive the expression to compute the DTFS coefficients from the provided time domain representation $x[n]$. Why Gibb's phenomenon is not observed in DTFS? [ ]

c. A composite signal $g(t)$ is shown below. [3]
Does the FT of the signal exist? If yes, Find the CT Fourier transform $G(j\omega)$ of the signal.
Can you use the above result to find the CTFT of the signum function defined as:

$$x(t) = \begin{cases} 1, & for\ t > 0 \\ -1, & for\ t < 0 \end{cases}$$



4. a. A DT sinusoid with the fundamental period of 6 is defined as below:]

$$y[n] = \sin\left(\frac{2\pi}{6}n + \frac{\pi}{4}\right).$$

Obtain the exponential FS coefficients and hence the spectrum of the signal.

b. A rectangular gate function $x(t)$ has the FT $X(j\omega) = 2T_1 sinc\left(\frac{\omega T_1}{\pi}\right)$. Using the properties of the FT, find the FT of the signal $x\left(2 - \frac{t}{2}\right)$. [2]

c. Find the DTFT of the DT signal $x[n] = a^n u[n]$. Show the approximate magnitude spectrum for $a = 1$ and $a = -1$. [3]

d. State and prove the convolution property of CTFT. [3]

5. a. DTFT of a signal $x[n]$ is given as $X(e^{j\Omega}) = \begin{cases} 0, & for\ 0 < |\Omega| < \Omega_c \\ 1, & for\ \Omega_c < |\Omega| < \pi \end{cases}$. Find the signal $x[n]$. [3]

b. A signal $x(t) = 10\cos(150\,\pi t)$ is ideally sampled using impulse train sampling at a sampling frequency $f_s = 200\ samples\ per\ second$. Using FT to represent the signals in frequency domain, obtain and sketch the spectrum of both $x(t)$ and sampled signal $x_p(t)$. [3]

c. If a band limited signal is sampled such that a Nyquist criterion is satisfied, it can be reconstructed exactly from its samples. Explain the principle of ideal reconstruction and obtain the expression of reconstructed signal. [3]

d. What do you understand by Gaussian White noise? [2]

6. a. Rayleigh's energy theorem enables us to compute the total energy of finite duration signals in frequency domain. State and prove Rayleigh's energy theorem and also define the term 'ESD' associated with it. [3]

b. The total energy of a exponential pulse $y(t) = e^{-at}u(t)$ is equal to $\frac{1}{2a}$. The FT of the pulse $(j\omega) = \frac{1}{a+j\omega}$. What percent of energy is contained within the frequency range $-a < \omega < a$? [3]
Use the standard integration identity: $\int \frac{1}{a^2+x^2}dx = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right)$.

c. A real valued band limited message signal $x(t)$ with spectrum [3]
$$X(j\omega) = 0\ for\ |\omega| > 2000\pi$$
is amplitude modulated to produce an AM signal $g(t) = x(t)\sin(2000\,\pi t)$. Demodulation technique is applied to recover $x(t)$ from $g(t)$ as shown below. If the cutoff frequency of the LPF used is 2000π and pass band gain is 2, determine the modulated signal $y(t)$. Is it same to $x(t)$?

d. Discuss full AM with time domain and frequency domain expressions. [2]