BITS Pilani, Dubai Campus

II SEMESTER 2011-2012

COMPREHENSIVE EXAM

EEE/ECE/INSTR C272 CIRCUITS AND SIGNALS

12 JUNE 2012 **MAX MARKS: 80**

DURATION: 3 HOURS **WEIGHTAGE: 40%**

PART A (Total: 40 Marks)

Question 1 (4 x 2 = 8 Marks)

Describe a method/test to identify whether a system is

i. Linear or Non-linear
ii. Causal or Non-causal
iii. Lumped parameter system or Distributed parameter system
iv. Continuous-time system or Discrete-time system

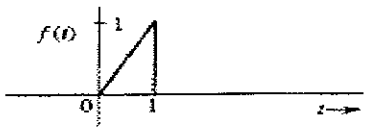
Question 2 (2 x 3 = 6 Marks)

A first-order all pass filter impulse response is given by $h(t) = -\delta(t) + 2e^{-t}u(t)$

i. Find the zero-state response of this filter for the input $e^{t}u(-t)$.
ii. Sketch the input and the corresponding zero-state response.

Question 3 (2 x 4 = 8 Marks)

Consider the signal f(t) shown below:



i. Find the trigonometric Fourier series of f(t) over the interval [0, 1]. Use $\omega_0=2\pi$. Sketch the Fourier series for all t.
ii. Compute the energy of the error signal e(t) if the number of terms in the Fourier series are N for N = 1, 2, 3 and 4.

Question 4 (2 x 3 = 6 Marks)

A TV signal (video and audio) has a bandwidth of 4.5 MHz. This signal is sampled, quantized and binary-coded to obtain a pulse code modulated (PCM) signal

i. Determine the sampling rate if the signal is to be sampled at a rate 20% above the Nyquist rate.
ii. If the samples are quantized into 1024 levels, what number of binary pulses is required to encode each sample.
iii. Determine the binary pulse rate (bits/sec.) of the binary coded signal.

Question 5 (4 Marks)

Prove that a signal cannot be simultaneously time limited and band limited.

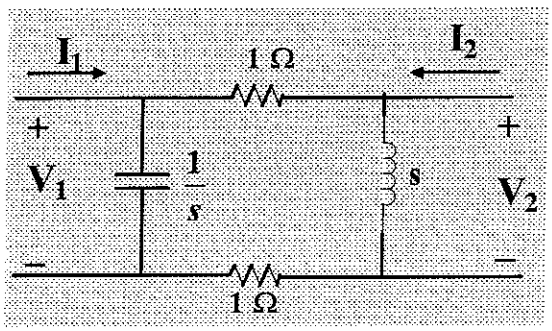
Question 6 (8 Marks)

Using DIT FFT algorithm determine DFT of the sequence x[n] = 1, 1, 2, 2, 3, 3, 4, 4

Part B (Total: 40 Marks)

Question 1 (Total: 4 + 6 = 10 Marks)

i. Obtain the algebraic expression for the **Z** parameters and **h** parameters in terms of **Y** parameters.
ii. For the circuit given below, obtain the **Y**, **Z** and **h** parameters.



Question 2 (Total: 2 + 3 + 4 + 6 = 15 Marks)

i. For the circuit in Question 1, obtain the Laplace Transform of $V_2(s)/V_1(s)$ for zero initial conditions.
ii. Obtain the time domain function $V_2(t)/V_1(t)$ for zero initial conditions.
iii. Assume that at t = 0-, there is no current in the inductor but there is an initial voltage of 2 V across the capacitor. Given that $V_1(t)$ is 10 u(t), what is $V_2(t)$ for these initial conditions, if ?
iv. Obtain the magnitude of $V_2(s)/V_1(s)$ by substituting s = jw. Calculate the magnitude of this transfer function for f = 1 Hz, 10 Hz, 100 Hz, 1 KHz, 10 KHz, 1 MHz. Is this a low pass or high pass or band pass filter?

Question 3 (Total: 2 + 2 + 2 + 1 + 1 + 1 + 2 + 4 = 15 Marks)

i. Plot $f(n) = (0.9)^n [u(n-3) - u(n-11)]$.
ii. Plot f(2n).
iii. Plot f(n/2).
iv. Plot $f(t) = (0.9)^t [u(t-3) - u(t-11)]$.
v. Plot f(2t).
vi. Plot f(t/2).
vii. Compare and contrast the above operations for continuous and discrete-time.
viii. Obtain the Z transform of f(n), f(2n) and f(n/2).

Useful Formulae

$$V_1 = z_{11}I_1 + z_{12}I_2$$
$$V_2 = z_{21}I_1 + z_{22}I_2$$

$$I_1 = y_{11}V_1 + y_{12}V_2$$
$$I_2 = y_{21}V_1 + y_{22}V_2$$

$$V_1 = h_{11}I_1 + h_{12}V_2$$
$$I_2 = h_{21}I_1 + h_{22}V_2$$

$$V_1 = AV_2 - BI_2$$
$$I_1 = CV_2 - DI_2$$

$$I_1 = g_{11}V_1 + g_{12}I_2$$
$$V_2 = g_{21}V_1 + g_{22}I_2$$

$$V_1 = AI_1 + BV_2$$
$$I_2 = CI_1 + \frac{V_2}{D}$$

BITS Pilani, Dubai Campus

Dubai International Academic City

Second Semester 2011-2012

Test 2 (Open Book)

Date: 13 May 2012 **Weightage: 20%**

Duration: 50 minutes **Marks: 40 Marks**

Note: Show all working to get full credit

Question 1 (8 MARKS)

For a signal f(t) that is time-limited to 10 ms and has an essential bandwidth of 10 kHz, determine N_o, the number of signal samples necessary to compute a power of 2-FFT with frequency resolution of F_o of at least 50 Hz. Explain if any zero padding is necessary.

Question 2 (12 MARKS)

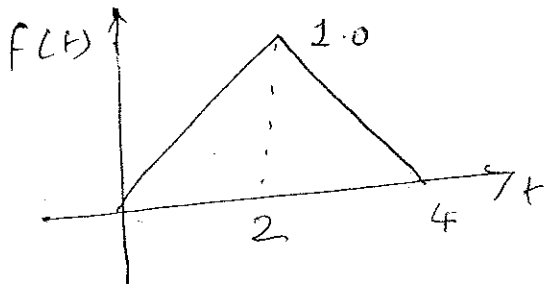
An 8 point sequence is given by x(n) = {2,2,2,2,1,1,1,1}. Compute 8 point DFT of x(n) by radix-2 DIT FFT

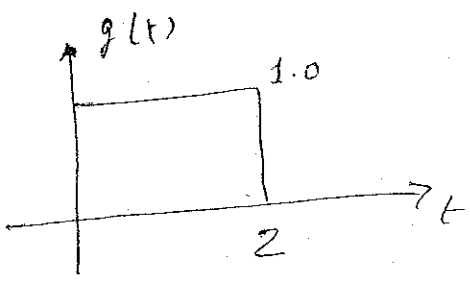
Question 3 (10 Marks)

Compute the DFT sequence for x(n) = {-1, 6,3}.

Question 4 (10 Marks)

Determine the Laplace Transform of the convolution of the following signals i.e., LT{f(t)*g(t)}.





BITS PILANI – DUBAI

International Academic City, Dubai

Second Semester 2011 – 2012

Circuits and Signals EEE/ECE/INSTR C272 (II year)

Test 1 (Closed Book)

Duration : 50 minutes **Weightage : 25%**

22 March 2012 **MAX : 50 Marks**

Note: Show all working to get full credit.

1. Sketch each of the following signals: **(2 + 2 + 2 = 6 Marks)**
   a. u(t-5) + u(t-7)
   b. t^2[u(t-1) – u(t-2)]
   c. (t-4)[u(t-2) – u(t-4)]

2. A first-order all pass filter impulse response is given by $h(t)=-\delta(t)+2e^{-t}u(t)$. **(4 + 4 = 8 Marks)**
   a. Find the zero-state response of this filter for the input: $e^{t}u(-t)$.
   b. Sketch the input and the corresponding zero-state response.

3. Prove the following: **(6 + 6 = 12 Marks)**
   a. Time-scaling property defined as: If f(t)*g(t)= c(t), then, f(at) *g(at) = $\left|\frac{1}{a}\right|$ c(at).
   b. The convolution of an odd and an even function is an odd function and the convolution of two odd or two even functions is an even function.

4. a) Determine c[k] = f[k]*g[k] (obtain the general expression in terms of a summation) for
   $f[k] = (0.9)^{k-2}\,u(k-2)$
   $g[k] = (0.5)^{k-3}\,u(k-3)$

   b) Calculate c[5], c[6], c[7], c[8]. **(4 + 4 = 8 Marks)**

5. Given the exponential Fourier series coefficients, $D_n = 0.3046/(1+2jn)$,

(2 + 2 + 4 = 8 Marks)

   a. Calculate the ***magnitude*** of D_1, D_{-1}, D_2, and D_{-2}.
   b. Calculate the ***phase*** of D_1, D_{-1}, D_2, and D_{-2}.
   c. The general expression for the power of this signal.

6. The Fourier Transform of $e^{-2t}u(t)$ is $1/(2+j\omega)$. **(2 + 2 + 2 + 2 = 8 Marks)**

   a. What is the Fourier transform of $e^{2t}\,u(-t)$?
   b. What is the Fourier transform of $e^{-2(t-2)}\,u(t-2)$?
   c. What is the Fourier transform of $e^{-t}\,u(t)$?
   d. What is the ***inverse*** Fourier Transform of $1/[2+j(\omega-2)]$

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Second Semester 2011 – 2012

Circuits and Signals ECE/EEE/INSTR C272 (II year)

Quiz 2 Set A (Closed Book)

Duration: 20 minutes **Weightage: 7%**

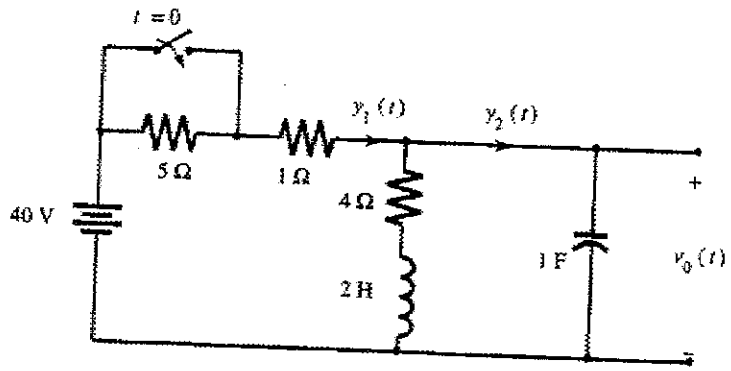
24 May 2012 **MAX: 14 Marks**

Note: Show all working to get full credit.

Question 1 (7 Marks)

For the circuit in Figure below, the switch is open position for a long time before t=0, when it is closed instantaneously. For $t \geq 0$, solve for the following:

a) Inductor current, $y_1(t)$ and
b) Current through capacitor, $y_2(t)$



Question 2 (2 Marks)

Write down one example of a first order differential equation and one example of a first order difference equation.

Question 3 (1 Mark)

Draw the following discrete sequence in the form of a graph: {-1, 5, 4, 3}.

Question 4 (1 Mark)

Write the discrete time signal u(n) as a sum of impulse functions.

Question 5 (2 Marks)

Draw the discrete time sequence for $2^n - 2^{n-1}$ for n =1, 2, 3, 4.

Question 6 (1 Mark)

If the discrete time sequences f(n) and g(n) are periodic, is **f(n)g(n)** periodic. Justify.

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Second Semester 2011 – 2012

Circuits and Signals ECE/EEE/INSTR C272 (II year)

Quiz 2 Set B (Closed Book)

Duration: 20 minutes **Weightage: 7%**

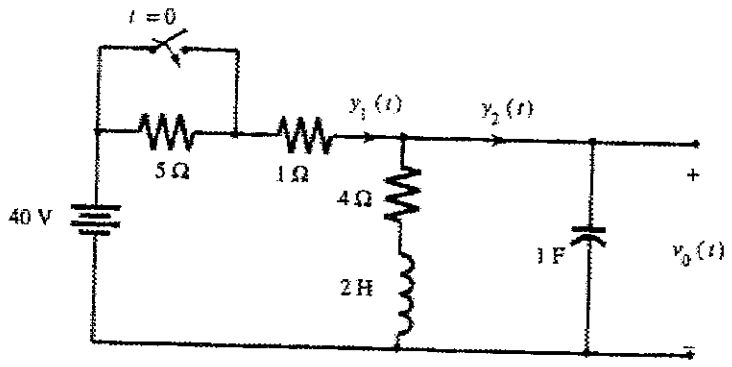
24 May 2012 **MAX: 14 Marks**

Note: Show all working to get full credit.

Question 1 (7 Marks)

For the circuit in Figure below, the switch is open position for a long time before t=0, when it is closed instantaneously. For $t \geq 0$, solve for the following:

a) Inductor current, $y_1(t)$ and
b) Current through capacitor, $y_2(t)$



Question 2 (2 Marks)

Write down one example of a second order differential equation and one example of a second order difference equation.

Question 3 (1 Mark)

Draw the following discrete sequence in the form of a graph: {-5, -2, 6, 3}.

Question 4 (1 Mark)

Write the discrete time signal $\delta(n)$ as a difference of two step functions.

Question 5 (2 Marks)

Draw the discrete time sequence for $3^n - 3^{n-1}$ for n =1, 2, 3, 4.

Question 6 (1 Mark)

If the discrete time sequences f(n) and g(n) are periodic, is **f(n) + g(n)** periodic. Justify.

BITS PILANI – DUBAI
International Academic City, Dubai
Second Semester 2011 – 2012
Circuits and Signals ECE/EEE/INSTR C272 (II year)
Quiz 1 Set A (Closed Book)

Duration: 20 minutes **Weightage: 8%**
5 March 2012 **MAX: 8 Marks**

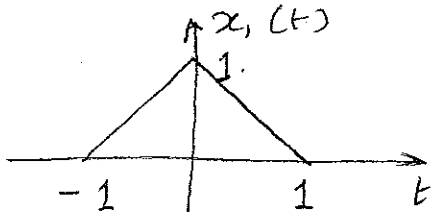
Note: Show all working to get full credit.

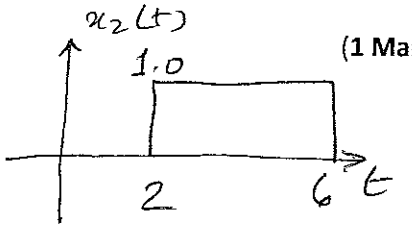
1) Determine the power of the signal: **$10\cos(100t+\pi/3)$**. **(1 Mark)**

2) Find and sketch the odd and the even components of **$\sin \omega_0 t$**. **(1 + 1 = 2 Marks)**

3) A System with input **f(t)** and output **y(t)** is described by the equation: **y = f(t-2)**. Determine whether the system is causal or non-causal. **(1 Mark)**

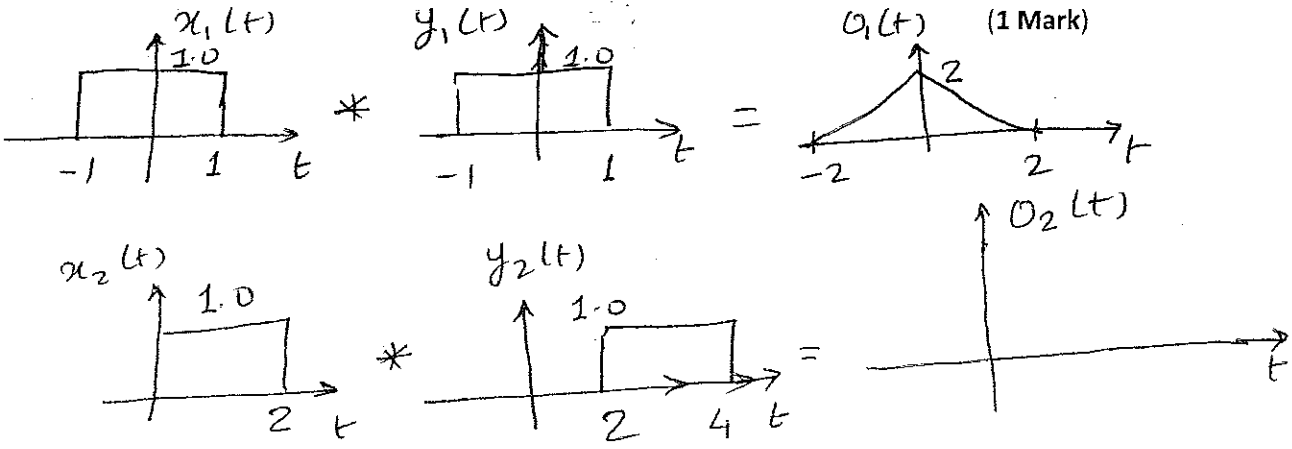
4) What is the width of the output signal when I convolve the following signals?





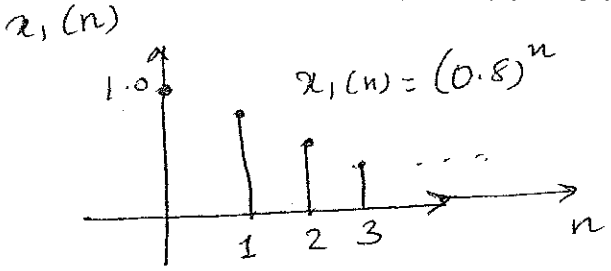
(1 Mark)

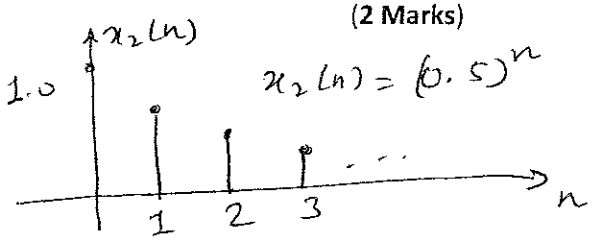
5) When you convolve the signals $\mathbf{x_1(t)}$ and $\mathbf{y_1(t)}$ below, the output signal $\mathbf{o_1(t)}$ is obtained. What is the convolved output signal $\mathbf{o_2(t)}$, when $\mathbf{x_2(t)}$ and $\mathbf{y_2(t)}$ below are convolved?



(1 Mark)

6) For the discrete signals $\mathbf{x_1(n)}$ and $\mathbf{y_1(n)}$ given below, what are the outputs y(0) and y(1)?





(2 Marks)