THIS PAPER MUST NOT BE REMOVED FROM THE EXAMINATION ROOM	STUDENT NAME: STUDENT NUMBER:

Internal Students Only

THE UNIVERSITY OF QUEENSLAND

School of Information Technology & Electrical Engineering

First Class Test – April 2, 2012

ELEC 3004 / 7312:

Signals Systems & Controls

(Exam Sort I)

CLOSED BOOK

TIME: **FORTY FIVE (45)** minutes for working

FIVE (5) minutes for perusal before examination begins

ANSWER ALL QUESTIONS ON SHEET PROVIDED

QUESTIONS CARRY THE NUMBER OF MARKS INDICATED

Drawing instruments and one battery-operated or solar-powered electronic calculator may be used but NO pre-programmed material or calculator instruction booklets are allowed in the examination room.

Please Answer 11 of the following 12 Questions.
Please specify the "null answer" question with a ∅ on the answer sheet
(9 marks each)

Signals

1. What is the fundamental period of the following signal:

$$x(t) = \sin^2(t)$$

   (a) $\frac{\pi}{2}$
   (b) π
   (c) 2π
   (d) It is not periodic
   (e) None of the above

2. Which of the following is FALSE for the following system:

$$y[t] = x[t] - x[t-1]$$

   (a) Linear
   (b) Time invariant
   (c) Causal
   (d) A differentiator
   (e) None of the above

Sampling

3. *Can a whistle be heard over a telephone?* If a metal pea whistle that rings at 4800 Hz is sampled at 8000 Hz (POTS sample rate), then what is the dominant frequency present in the sampled signal?

   (a) 0 Hz
   (b) 800 Hz
   (c) 3.2 kHz
   (d) 4.0 kHz
   (e) None of the above

4. For a System with a Voltage range of 0V to 5V that is digitized using a 4-bit ADC, what is the minimum voltage quantization?

   (a) 0.156 V
   (b) 0.333 V
   (c) 0.625 V
   (d) 1.25 V
   (e) None of the above

5. For a signal $x(t)$ with a Nyquist rate f_n, what is the Nyquist rate for $x^2(t)$?

   (a) 0
   (b) f_n
   (c) $2f_n$
   (d) f_n^2
   (e) None of the above

Convolution

6. Which of the following statements is ***FALSE*** for convolution?

   (a) $x(t) * y(t) = y(t) * x(t)$,

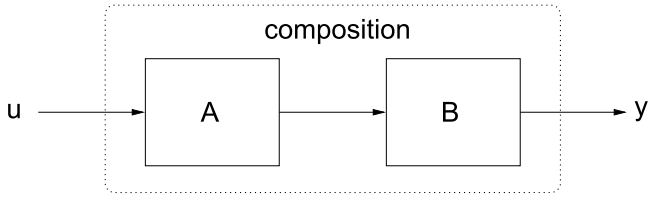
   (b) $x(t) * \{y(t) + z(t)\} = \{x(t) * y(t)\} + \{x(t) * z(t)\}$,

   (c) $x(t) * \delta(t - t_0) = \delta(t - t_0)$,

   (d) $x(t) * \{y(t) * z(t)\} = \{y(t) * x(t)\} * z(t)$,

   (e) None of the above.

7. A composition of linear convolution systems, implies:



   (a) Multiplication of transfer functions (or blocks) (i.e., $y(t) = BAu(t)$)

   (b) Convolution of impulse functions

   (c) Commutation of transfer functions (or blocks)

   (d) All of the above

   (e) None of the above

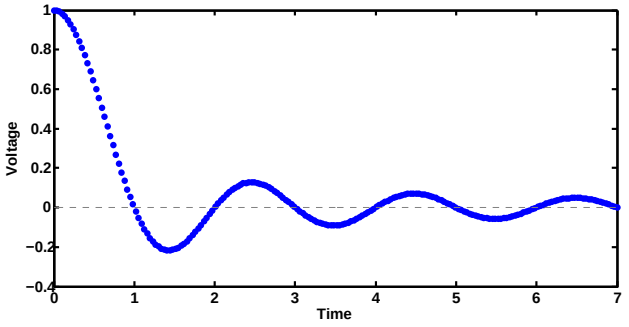
Systems

8. Which of the following rows in this Laplace Transform table are ***WRONG***?

Property	$x(t)$	$X(s)$
Linearity	$ax_1(t) + bx_2(t)$	$aX_1(s) + bX_2(s)$
Delay by T	$x(t-T)$	$e^{-sT}X(s)$
Multiply by t	$tx(t)$	$\frac{-dX(s)}{ds}$
Multiply by $e^{-\alpha T}$	$x(t)e^{-\alpha T}$	$X(s+\alpha)$
Differentiate	$\frac{dx(t)}{dt}$	$sX(s)$
Integration	$\int_{-\infty}^{t} x(\lambda)d\lambda$	$\frac{X(s)}{s}$

(a) Linearity
(b) Multiple by t
(c) Differentiate
(d) Integration
(e) None of the above

9. A signal is sampled to give the following: What function best describes its Fourier Transform



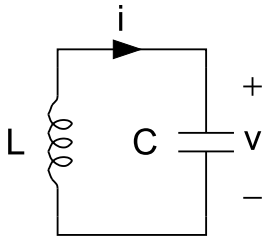
(hint: Any offset (DC bias) is negligible, notice that time starts at 0)?

(a) 1
(b) $sinc(f)$
(c) $rect(f)$ is a rectangular function
(d) $tri(f)$ where $tri(f)$ is a triangular function
(e) None of the above

10. IF $g(.)$ is a Gaussian (i.e., $g(t) = ae^{-\frac{(t-b)^2}{2c^2}}$ for a given set of real constants a, b and c) and IF $\mathcal{F}$ is the Fourier transform operation, THEN what is $\mathcal{F}\{g(t) \cdot g(t)\}$?

(a) 0,
(b) $2g(f)$,
(c) $g^2(f)$,
(d) $sinc(f)$,
(e) None of the above

11. Given an LC Circuit, what is the oscillation frequency of the voltage (hint: remember that $i = C\dot{v}$ and $v = -L(\dot{i})$?



(a) $\omega = \sqrt{LC}$

(b) $\omega = LC$

(c) $\omega = \frac{1}{(\sqrt{LC})}$

(d) It does not oscillate

(e) None of the above

12. *Does rainfall signal floods?* A river's height, $y(t)$ (meters), may be modelled as function of rainfall rate, $u(t)$ (cm/hour), above a reference (dry period) level, at time t (hours). Previous analysis suggests that this may be described by a transfer function[1], $Y(s) = H(s)U(s)$ with

$$H(s) = \frac{3}{(3s+1)(30s+1)}$$

After a brief and very intense downpour (an "impulse" of rain), what is the ultimate height of the river (i.e., $\lim_{t\to\infty} y(t)$, ignoring other effects such as tides, etc.)?

(a) $1/30$m

(b) $1/3$m

(c) 1.5m

(d) 3m

(e) None of the above

[1] In case you are curious, the physical basis of this two-pole transfer function is that runoff from surface water and small tributaries is small, but quick and gives a "fast pole," whereas the larger volume and slower flow from larger tributaries and ground water absorption contribute to the "slow pole")

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