Birla Institute of Technology and Science, Pilani

II Semester 2013-2014, EEE F243 / INSTR F243, Signals & Systems
Comprehensive examination CLOSED BOOK
May 11, 2014 (Sunday) AN

MM: 30 **Time: 1 hr**

- **Questions are printed on BOTH sides (total 15 questions). Symbols have their usual meanings.**
- **Answers should be CLEAR, CONCISE AND LEGIBLE. Specify your assumptions clearly.**
- **YOUR ANSWERS MUST BE JUSTIFIED. Simply writing yes/ no will not fetch you any marks.**
- **All parts of a question must be answered together and in the same sequence as given in question paper. ELSE QUESTION SHALL NOT BE EVALUATED.**
- **NO MARKS will be awarded for plots without proper labeling of axes.**

Q1. The sequence $\{0,-\sqrt{2},-2,\ 0,\ \sqrt{2},\ 2,\ \sqrt{2}\}$ represents a periodic sinusoidal sequence $x[n] = A\sin(\omega_0 n+\varphi)$. Determine the values of the parameters A and ω_0. [1]

Q2. Determine and justify whether the following system is linear and time-invariant or not?

$$y(t) = \int_{-\infty}^{2t} x(\tau)d\tau$$

[1]

Q3. The non-zero Fourier series coefficients in exponential form of a continuous-time periodic signal f(t) with fundamental time period T = 8, are expressed as, $F_1 = F^*_{-1} = 2$; $F3 = F^*_{-3} = 4j$. Determine the signal f (t) in its sinusoidal form. [2]

Q4. For an LCR circuit the transfer function is, $H(s) = \dfrac{RCs}{LCs^2 + RCs + 1}$, with the following component values as, R = 10Ω, C = 10μF and L = 10mH. Determine what kind of filter this LCR circuit encompasses, by sketching the pole-zero positions in the complex frequency plane. [3]

Q5. Transfer function of a first order low pass filter (LPF) with 3dB cutoff frequency f_c, is given by, $H(f) = \dfrac{1}{1+j(f/f_c)}$. This LPF is used as an anti-aliasing filter, when an analog signal x(t) is sampled at a rate f_s. What is the minimum value for f_s, if the amplitude response to the aliased component at the edge of the pass band i.e. $f_s - f_c$, is to be at least 30dB below the amplitude response at f_c? [3]

Q6. Realize the following system transfer function into cascade and parallel forms. [3]

$$H(s) = \frac{s(s+2)}{(s+1)(s+3)(s+4)}$$

Q7. A signal has Laplace transform of the form $X(s) = \frac{s+1}{s^2+3s+4}$

Find the Laplace transform Y(s) of the following signals using Laplace transform properties only.

(a) $y(t) = e^{-2t}x(t)$

(b) $y(t) = x(t) * x(t)$

Q8. Determine whether the following system is linear or non linear.

$$y[n] = n^2 x[n-1]$$

Q9. What is the importance of impulse response? Does the impulse response of a nonlinear characterize the system? Determine whether the following system is causal or non causal.

$y(t) = x(t)\cos(t+1)$

Q10. Find the Nyquist rate & the Nyquist interval for the following signal.

$x(t) = -10\sin(40\pi t)\cos(300\pi t)$

Q11. State Parseval's theorem for energy signals. When the z-transform & discrete –time Fourier transfo same?

Q12. Sketch the following signals & determine whether they are energy signals or power signals o Calculate the respective energy or power values. (a) $u(t) - u(t-3)$ (b) $\left(2 + e^{-6t}\right)u(t)$

Q13. Consider a sinusoidal signal $x(t) = \cos 15t$

(a) Find the expression for the sampling interval (T_s) such that $x[n] = x(nT_s)$ is periodic.

(b) Find the fundamental period for x[n] if the folding frequency for sampling is $5/\pi$ Hz. Comment o periodicity of x[n].

Q14. Consider a sequence $x[n] = \sum_{k=-\infty}^{\infty} \delta[n-4k]$. (a) Sketch x[n]. (b) Find the Fourier series coefficient w for x[n].

Q15. Let x(t) be a real valued band limited signal. If it is sampled at a rate Ts, then find the Fourier transfo the sampled signal.