Code No: R21044 **R10** SET - 1

II B. Tech I Semester Regular Examinations, March – 2014
SIGNALS AND SYSTEMS
(Com. to ECE, EIE, ECC, BME)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) Explain about complex exponential function and show that the complex exponential functions are orthogonal functions.
   b) Derive the relation between unit step function and signum function along with their appropriate definitions. (8M+7M)

2. a) A function *x(t)* is given by $x(t)=\begin{cases} e^{-t} & 0\le t\le 1 \\ 0 & else\ where\end{cases}$ and the function is repeated every T = 1 sec. With unit step function u(t), if $y(t)=\sum_{n=-\infty}^{\infty} a(t-n)u(t-n)$ then find the exponential Fourier series for y(t).
   b) Explain about the Dirichlet's condition for Fourier series. (8M+7M)

3. a) Find the Fourier Transform of a signal given by $10\sin^2(3t)$.
   b) State and prove the following properties of Fourier transform
   i) Multiplication in time domain ii) Convolution in time domain (7M+8M)

4. a) What is poly-wiener criterion and explain how it is related to physical reliability of a system
   b) Find the impulse response h(t) of an LTI system with the input and output related by the equation $y(t)=\int_{-\infty}^{\infty} e^{-(t-\tau)}x(\tau-2)$. (8M+7M)

5. a) Compute the auto correlation function of the following signal shown in Figure 1 below:

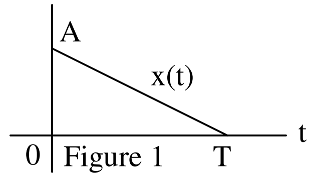

Figure 1

   b) Prove that the auto-correlation function and energy density spectrum form a Fourier transform pair. (8M+7M)
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6. a) Explain sampling theorem for Band limited signals with a graphical example
   b) Derive the expression for transfer function of flat top sampled signal. (8M+7M)

7. a) Find the Laplace transform of $\left[4e^{-2t}\cos 5t - 3e^{-2t}\sin 5t\right]u(t)$ and its region of convergence.
   b) Find the inverse Laplace transform of $x(s) = \dfrac{1+e^{-2s}}{3s^2+2s}$. (8M+7M)

8. a) Find the Z-transform of $x(n) = \left(\dfrac{1}{4}\right)^n u(n) + \left(\dfrac{1}{3}\right)^n u(-n-1)$.
   b) Find the inverse Z-transform of $x(z) = \dfrac{z}{z(z-1)(z-2)^2}$ for $|z| > 2$. (8M+7M)

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1. a) Verify the orthogonality of the following functions: $S_1(t) = 1$ and $S_2(t) = c(1-2t)$ in the interval [0 1].
   b) Find whether the following signals are even or odd
   i) $x(n) = \sin(-2\pi n)$ ii) $x(n) = \cos(2\pi n)$ (7M+8M)

2. a) Find the exponential Fourier series of a signal $x(t) = \cos 5t \sin 3t$.
   b) Find the trigonometric Fourier series of $f(x) = 3x$ and $x \in (-\pi, \pi)$. (8M+7M)

3. a) Find the Fourier Transform of $Ae^{-|at|} \sin c 2wt$ by applying convolution theorem.
   b) Find Fourier transform of a burst of N cycles of a sine wave of period T_0 seconds. A burst of sine wave can be modeled as an infinite duration signal multiplied by a rectangular window, and then employ the convolution property of the Fourier transform for the product of two signals. Sketch the spectrum of the signal. (7M+8M)

4. a) For an LTI system described by the transfer function $H(s) = \dfrac{s+3}{(s+2)^2}$. Find the response to The following inputs i) $\cos(2t+60)$ ii) e^{j3t}
   b) Derive the relationship between bandwidth and rise time. (9M+6M)

5. a) Find the auto correlation function of a signal $R(z) = e^{-2\alpha|\tau|}$ and also determine the spectral density of the process.
   b) Find the energy in the signal $f(t) = e^{-at}u(t)$ and find the bandwidth ω such that 95% of the energy is contained in frequency below ω. (8M+7M)
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6. a) The Fourier transform of a sampled signal is given by $x(f) = \sum_{m=0}^{N-1} x(m) e^{-j2\pi fm}$

   Using the above equation, prove that the spectrum of a sampled signal is periodic, and hence state the sampling theorem.

   b) Explain the effects of under sampling with suitable examples. (8M+7M)

7. a) Find the Laplace transforms of the following function using the time-shifting property where ever it is appropriate

   i) $u(t) - u(t-1)$ ii) $e^{-t} u(t - \tau)$

   b) Find inverse Laplace transform of the following function $e^{-2s}\left(\frac{2s+5}{s^2+5s+6}\right)$. (8M+7M)

8. a) Compare Laplace transform and Fourier transform in detail.

   b) Find the inverse z transform of $\frac{z(22-5z)}{(z+1)(z-2)^2}$. (7M+8M)

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1. a) Define mean square error and derive the equation for evaluating mean square error.
   b) Derive the condition for orthogonality of two signals and also prove that $\sin(nw_0t)$ and $\cos(mw_0t)$ are orthogonal to each other for all integer values of m and n. (7M+8M)

2. a) Represent the Fourier series of the signal $x(t) = 3\cos\left(\frac{\pi}{4}+\frac{\pi t}{2}\right)$ using the method of inspection.
   b) Find the Fourier series of a triangular function given by the equation $g(x) = \pi + x$ for $-\pi \le x \le 0$ else $g(x) = \pi - x$ for $0 \le x \le \pi$ (8M+7M)

3. a) Find the Fourier Transform of the following
   i) Impulse function δ(t) ii) Unit step function.
   b) Find Inverse Fourier Transform of $x(\omega) = \frac{1}{\sqrt{1+\omega^2}} e^{\left(-j\tan^{-1}(\omega)\right)}$ (8M+7M)

4. a) Describe and compare all the ideal characteristics of low pass, high pass and band pass filters
   b) Define signal bandwidth and obtain the conditions for the distortion less transmission through a system. (8M+7M)

5. a) Explain how a signal is extracted from a noisy environment by using filtering technique.
   b) Distinguish between Energy spectral density and power spectral density and also state and prove Parseval's theorem for energy signal. (7M+8M)

6. a) Consider the analog signal $x_a = 3\cos(100\pi t)$ then i) determine the minimum sampling rate required to avoid aliasing ii) suppose the signal is sampled at two different sampling rates of $f_s = 200HZ$ and $f_s = 75HZ$, then find the discrete time signals obtained after sampling in each case separately
   b) Explain about band pass sampling. (6M+9M)

7. a) Find the Laplace transform of $f(t) = \cos t$ for $0 < t < 2\pi$ and $f(t) = 1 - \sin t$ for $t \ge 2\pi$
   b) Find the inverse Laplace transform of $F(s) = \frac{e^{-s}(s-2)}{(s^2-4s+3)}$. (8M+7M)

8. a) Find the Z-Transform of $x[n] = 7\left(\frac{1}{3}\right)^n \cos\left(\frac{\pi}{4}+\frac{2n\pi}{6}\right)u[n]$.
   b) Find the inverse Z-Transform of $x(z) = \frac{2z(3z+17)}{(z-1)(z^2-6z+25)}$. (8M+7M)
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1. a) Prove that sinusoidal functions and complex exponential functions are orthogonal functions.

   b) A rectangular function defined as $f(t)=\begin{cases} A & 0<t<\dfrac{\pi}{2} \\ -A & \dfrac{\pi}{2}<t<\dfrac{3\pi}{2} \\ A & \dfrac{3\pi}{2}<t<2\pi \end{cases}$. Approximate the above rectangular function by $A\cos t$ between the intervals $(0, 2\pi)$ such that mean square error is minimum. (7M+8M)

2. a) Calculate the Fourier series coefficients of the following continuous-time signal
   $x(t)=\begin{cases} 1 & for\ \ 0\le t\le 1 \\ -1 & for\ \ 1\le t\le 2 \end{cases}$ With a fundamental period of 2.

   b) Determine the Fourier series coefficients for the signal $x(t)$ shown in below figure 1. (8M+7M)

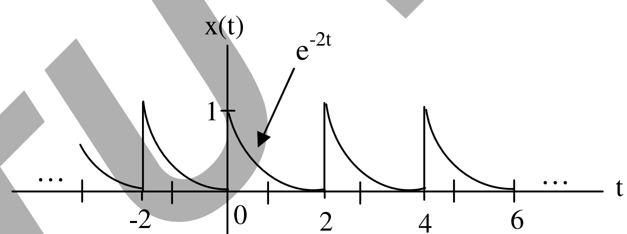

Figure 1

3. a) A system has the output $y[n]=\left(\frac{1}{2}\right)^n u(n)+\frac{1}{2}\left(\frac{1}{4}\right)^n u(n)$ for the input $x[n]=\left(\frac{1}{4}\right)^n u(n)$

   i) Find the Fourier transforms of both $x[n]$ and $y[n]$

   ii) Find the frequency response $H\left(e^{jw}\right)$

   b) Explain about Hilbert Transform with appropriate equations. (9M+6M)
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4. a) For an input signal $x(t)=\delta(t)+e^{-t}u(t)$ and a LTI system with an impulse response $h(t)=e^{t}u(-t)$ Find the output y(t)
   b) Derive the relationship between bandwidth and rise time of a low pass filter. (8M+7M)

5. a) Find the total energy of the signal $x(t)=\dfrac{\sin(10t)}{\pi t}$ using the Parseval's equation
   b) Prove that the auto-correlation function and energy density spectrum form a Fourier transform pair. (8M+7M)

6. a) A complex signal $x(t)$ with a Fourier transform $X(j\omega)$ is zero everywhere except for the interval $-5<\omega<2$. Using $X_p(j\omega)=\dfrac{1}{T}\sum_{K=-\infty}^{\infty}X(j(w-k\omega_s))$, determine the minimum sampling frequency ω_s to ensure a reconstruction of the original signal $x(t)$ without losing information
   b) Explain the effect of under sampling with an example and neat diagrams. (8M+7M)

7. a) Solve the following differential equation using Laplace transform $\dfrac{d^2y}{dx^2}+3\dfrac{dy}{dx}+2y=u_2(t)$ with the initial conditions $y(0)=0$ and $y(0)'=1$
   b) Find the inverse Laplace transform of $F(s)=\dfrac{(2s-3)}{(s^2+2s+10)}$. (8M+7M)

8. a) Find the Z-Transform of $u[nT]e^{-\alpha nT}\sin\omega nT$
   b) Find the inverse Z-Transform of $x(z)=\dfrac{z\left(2z^2-11z+12\right)}{(z-1)(z-2)^3}$. (8M+7M)