Reg. No.										

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

IV SEMESTER B.S. DEGREE EXAMINATION – MAY 2016

SUBJECT: SIGNAL PROCESSING (EC 244)

16TH MAY, 2016

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE full Questions.**

1A. Consider the signal, $x(t) = r(t+1) - 2r(t-1) + r(t-3)$, where r(t) is the unit ramp. Sketch and compute the energies of x(t), -x(t), x(2t-3), and 2x(1-2t). **(10M)**

1B. Explain linearity, causality and time-invariance properties of system. Determine whether the systems characterized by the following equations satisfy these properties or not.

(i) $y(t) = x^2(t) + \frac{dx(t)}{dt}$ (ii) $y[n] = e^{x[-n]}$ (iii) $y(t) = 2x(t) + 4\frac{dx(t)}{dt}$. **(10M)**

2A. Consider a LTI system having impulse response $h(t) = -u(t-2) - u(t-1) + u(t+1) + u(t+2)$. Compute the response of the system for the input $x(t) = e^{-2t}u(t-3)$ using time-domain convolution. Clearly show all the steps. **(10M)**

2B. Obtain the direct form-I and direct form-II implementations for the following LTI systems.

(i) $\frac{d^2\, y(t)}{dt} + \frac{1}{4}\frac{d\, y(t)}{dt} + 2y(t) = \frac{1}{2}\frac{d\, x(t)}{dt}$

(ii) $2y[n] + 3y[n-1] - y[n-2] - 2x[n-1] + 4x[n-2] = 0$. **(10M)**

3A. Find the step response of an LTI system having impulse response $h[n] = 2^n u[-n-1]$ using time-domain convolution. **(10M)**

3B. Derive the conditions to be satisfied by the impulse response in order for the discrete-time system to be causal, stable, invertible. Also determine whether the system described by $h[n] = n\left(\frac{1}{2}\right)^n u[n]$ is causal and stable. **(10M)**

4A. Determine inverse Fourier representation of, $X(e^{j\omega}) = \begin{cases} 1, & 0.1\pi \le |\omega| \le 0.3\pi \\ 0, & Otherwise\ in\ -\pi \le \omega \le \pi \end{cases}$ **(10M)**

4B. Use the suitable properties to obtain the appropriate Fourier representation for the signal,

$x[n] = \cos\left(\frac{\pi n}{2}\right)\left(\frac{1}{2}\right)^n u[n-2]$. **(10M)**

5A. Using linearity property, compute the Fourier transform of $x(t) = e^{-a|t|}$ and plot the magnitude spectrum. **(10M)**

5B. Using the suitable properties of Fourier transform, determine time signals for the following frequency domain functions. (i) $X(j\Omega) = \frac{j\Omega}{(2 + j\Omega)^2}$

(ii) $X(j\Omega) = \frac{j\Omega}{(j\Omega)^2 + 3j\Omega + 2}$. **(10M)**

6A. Certain LTI system is described by $\frac{d^2y(t)}{dt} + 3\frac{dy(t)}{dt} + 2y(t) = 2\frac{dx(t)}{dt} + x(t)$. Determine (i) Frequency response of the system (ii) Impulse response of the system and (iii) Output of the system for an input $x(t) = e^{-3t}u(t)$. **(10M)**

6B. Calculate the Nyquist rate and Nyquist interval for the following signals. (i) $x(t) = \frac{1}{2\pi}\cos(4000\pi t)\cos(1000\pi t)$ (ii) $x(t) = \frac{\sin(500\pi t)}{\pi t}$ **(10M)**

7A. Determine the Z-transform of $x[n] = \cos(\omega_0 n)u[n]$. Also give its pole-zero plot. **(10M)**

7B. Determine using partial fraction expansion, inverse Z-transform of $X(z) = \frac{1}{1 - 1.5z^{-1} + 0.5z^{-2}}$, $ROC : |z| < 0.5$ **(10M)**

8A. Compute the 8-point DFT of sequence x[n] = {1 1 1 1 0 0 0 0}. **(10M)**

8B. Plot the frequency response (in radians) plots of ideal low-pass, high-pass and band-pass digital filters. Assume the frequency range $-3\pi \le \omega \le 3\pi$. Also, distinguish between FIR and IIR filters. **(10M)**