Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

(A Constituent Institute of Manipal University)
Manipal – 576 104

III SEMESTER B.Tech (BME) DEGREE END-SEM EXAMINATIONNOV / DEC 2015

SUBJECT: SIGNALS AND SYSTEMS (BME 209)
(REVISED CREDIT SYSTEM)
Tuesday, Dec 08, 2015: 9.00a.m. - 12.00noon

TIME: 3 HOURS **MAX. MARKS: 100**

Instruction to Candidates:
Answer any FIVE full questions.

1. (a) Determine the exponential Fourier series and sketch the spectrum of a rectangular pulse train $f(t)$ defined over one period as $f(t) = \begin{cases} A \ ; \ |t| < \frac{\tau}{2} \\ 0 \ ; \ \frac{\tau}{2} < |t| < \left(T_o - \frac{\tau}{2}\right) \end{cases}$ The signal is periodic with a fundamental period T_o and has a duty cycle = 20%. (08)

   (b) Determine the overall impulse response $h[n]$ of the 2 discrete-time LTI systems having impulse responses $h_1[n] = \left(\frac{1}{2}\right)^n u[n]$ & $h_2[n] = \left(\frac{1}{4}\right)^n u[n]$ respectively, if they are connected in (i) series (ii) parallel (08)

   (c) What is the condition (based on the impulse response) for a discrete-time LTI system to be (a) Causal, (b) Stable? Investigate the causality and stability of the following discrete-time LTI systems. Justify your answer. (04)
   $(i)\ h(n) = 2\delta(n+1) + 3\delta(n) - \delta(n-1)$
   (ii) $h(n) = u(n+3) + u(n-2) - 2u(n-7)$

2. (a) A discrete-time LTI system has an impulse response $h[n] = 2\delta[n+1] + 2\delta[n-1]$. (08)
   If the input to the system is $x[n] = \delta[n] + 2\delta[n-1] - \delta[n-3]$, Compute and plot the output $y[n]$.

   (b) (i) Define Dirac delta function $\delta(t)$ and list its properties. (08)
   (ii) Prove that the Dirac delta function is the derivative of the step function $u(t)$ w.r.t time t.

   (c) A continuous-time signal $x(t)$ is obtained at the output of an ideal lowpass filter with cutoff frequency $w_c = 1000\pi\ rad/sec$. If impulse–train sampling is performed on $x(t)$, which of the following sampling periods would guarantee perfect recovery of $x(t)$ from its sampled version using an appropriate lowpass filter? (04)
   (i) T = $0.5\text{x}10^{-3}$ Sec (ii) T = $2\text{x}10^{-3}$ Sec (iii) T = 10^{-4} Sec

3. (a) State and prove the condition to be met to ensure perfect reconstruction of a band-limited signal, from its uniformly-spaced samples. (08)

   (b) Find and sketch the Fourier transform of the rectangular pulse given below. (08)
   $x(t) = \begin{cases} 1 \ ; \ |t| < T \\ 0 \ ; \ |t| > T \end{cases}$

(c) Derive the equation for the convolution sum. (04)

4. (a) Define linearity and time-invariance. A discrete-time system has the input-output relation given by (08)

(i) $y[n] = x[k_o n]$ where k_o is a positive integer. Determine whether this system is time-invariant.

(ii) $y[n] = x^2[n]$. Determine whether this system is linear.

(b) Illustrate the following properties of Fourier transform with an example. (08)

(i) Time-shifting (ii) Frequency-shifting (iii) Time-scaling

(c) A discrete-time signal is given by $x[n] = \{3,2,1,0,1,2,3\}$. (04)
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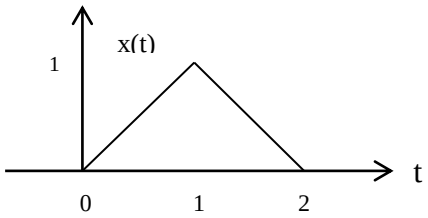
Sketch each of the following versions of the signal.
(i) $x[n]u[1-n]$ (ii) $x[n]\{u[n+2]-u[n]\}$ (iii) $x[n]\delta[n-1]$

5. (a) Consider a continuous-time LTI system described by the first order differential equation expressed by $\frac{dy(t)}{dt} + 2y(t) = x(t)$. Using the Fourier transform, find the output $y(t)$ of the system to the input $x(t) = e^{-t}u(t)$. (08)

(b) An LTI system is characterized by an impulse response $h[n] = \left(\frac{3}{4}\right)^n u[n]$. Find the step response of the system. (08)

(c) Illustrate Under-sampling and its consequence. (04)

6. (a) Using the time-differentiation property, find the Fourier transform of the signal $x(t)$ shown below. (08)



(b) Find the impulse response $h[n]$ for each of the causal discrete-time LTI systems satisfying the following difference equations: (08)
(i) $y[n] = x[n] - 2x[n-2] + x[n-3]$ (ii) $y[n] - \frac{1}{2}y[n-2] = 2x[n] - x[n-2]$

(c) A continuous-time signal $x(t)$ is shown below. Sketch and label each of the following versions of the signal. (04)

(i) $x(t)u(1-t)$

(ii) $x(t)[u(t) - u(t-1)]$

(iii) $x(t)\delta\left(t - \frac{3}{2}\right)$