Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
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III SEMESTER B.Tech.(BME) DEGREE END SEM EXAMINATIONS NOV/DEC 2016
SUBJECT: SIGNALS & SYSTEMS (BME 209)
(REVISED CREDIT SYSTEM)
Wednesday, 30th November 2016, 9AM - 12 NOON

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

Instructions to Candidates:

1. **Answer any FIVE full questions.**
2. **Draw labeled diagram wherever necessary**

1\. (a) State & prove the conditions for causality and stability of discrete-time LTI systems. 08

(b) Evaluate the convolution of $x[n]$ & $h[n]$ if, $x[n] = \{1, 0, \underset{\uparrow}{-1}, 2\}$ and $h[n] = \{2, \underset{\uparrow}{-1}, 1, 0, 2\}$. 08

(c) A discrete-time signal is given by $x[n] = \{1, 2, \underset{\uparrow}{3}, 2, 1\}$. 04

Sketch each of the following versions of the signal:
(i) $x[2n-1]$ (ii) $x[1-n]$ (iii) $x[-2n]$ (iv) $x[n+1]$.

2\. (a) (i) Define Dirac delta function $\delta(t)$ and list its properties. 06

(ii) Prove that the Dirac delta function is the derivative of the step function $u(t)$ w.r.t time t.

(b) 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 $y[n]$.

(c) A discrete-time signal is given by $x[n] = \{3,2,1,\underset{\uparrow}{0},1,2,3\}$. 06

Sketch each of the following versions of the signal.
(i) $x[n]u[1-n]$ (ii) $x[n]\{u[n+2] - u[n]\}$ (iii) $x[n]\delta[n-1]$

3\. (a) Determine whether the following signals are periodic. If they are periodic, find the fundamental period. 04

(i) $x[n] = \cos\left(\frac{1}{4}n\right)$ (ii) $x[n] = (-1)^n$

(b) State the sampling theorem. Illustrate under-sampling and its consequence. 08

(c) 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

4. (a) A continuous-time signal is described by 04

$$f(t) = 2\cos(2000\pi t) + 3\sin(6000\pi t) + 8\cos(12000\pi t).$$

If impulse train sampling is performed on the signal $f(t)$, which of the following sampling frequencies would guarantee that $f(t)$ can be recovered from its sampled version using an appropriate low pass filter?

(i) f_s=10kHz (ii) f_s=12kHz (iii) f_s=20kHz

(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) 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

5. (a) Consider a discrete-time LTI system with impulse response $h[n] = 2^n u[n]$. 04

(i) Is this system causal? (ii) Is this system stable?

Justify your answer.

(b) Consider a rectangular pulse train $f(t)$ defined over one period as 08

$$f(t) = \begin{cases} A \ ; & |t| < \frac{\tau}{2} \\ 0 \ ; & \frac{\tau}{2} < |t| < \left(T_o - \frac{\tau}{2}\right) \end{cases}$$

The signal is periodic with a fundamental period T_o and has a duty cycle=20%.

Determine the exponential Fourier series. Also, sketch the magnitude spectra.

(c) Explain the following system properties: 08

(i) Linearity (ii) Time invariance (iii) Causality (iv) Stability

6. (a) Prove that when the input to a discrete-time LTI system is expressed as a weighted sum of time-shifted impulses, the output is a weighted sum of time-shifted impulse responses. 06

(b) For the systems defined by the following input-output relationship, check for linearity, time-invariance, causality & stability: 08

(i) $y[n] = \frac{1}{3}\left[x[n] + x[n-1] + x[n-2]\right]$ (ii) $y(t) = x(t)\sin 6t$

(c) Illustrate the following properties of Fourier transform with an example. 06

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