Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

III SEMESTER B.Tech.(BME) DEGREE MAKE-UP EXAMINATIONS DEC/JAN 2016-17
SUBJECT: SIGNALS & SYSTEMS (BME 209)
(REVISED CREDIT SYSTEM)
Monday, 2nd January 2017, 9am to 12 Noon

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

Instruction to Candidates:

Answer any FIVE full questions.

1. (a) What is the condition 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. **08**

(i) $h[n] = 5\delta[n-2]$ (ii) $h[n] = u[n+2] + u[n-1] - 2u[n-3]$

(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) Sketch the following signals: **04**

(i) $u(t) - u(t-3)$ (ii) $u(t)u(1-t)$ (iii) $r(3-t)u(t)$ (iv) $e^{-2t}u(2-t)$

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) Evaluate and sketch $y(t)$, where: **08**

$y(t) = \{u(t+2) - u(t-1)\} * u(-t+2)$, and "*" denotes continuous convolution.

(c) A discrete-time signal is given by $x[n] = \{-1, -0.5, 0.5, \underset{\uparrow}{1}, 1, 1, 1, 0.5\}$. **06**

Sketch each of the following versions of the signal.
(i) $x[n-4]$ (ii) $x[3n+1]$ (iii) $x[n]u[3-n]$ (iv) $x[n-2]\delta[n-2]$

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) For the band-limited signal $x(t)$, construct the spectrum of the sampled signal under the following conditions: (i) $w_s \geq 2w_m$ (ii) $w_s < 2w_m$ **08**

Comment on the effect of under sampling.

(c) Consider two LTI systems with impulse responses $h_1[n] = \delta[n-2]$ and $h_2[n] = \delta[n-3]$ respectively. Calculate the overall impulse response $h[n]$, if the systems are connected in (i) cascade (ii) parallel. **08**

4. (a) Consider a continuous-time signal $x(t) = \cos(5\pi t) + 0.5\cos(10\pi t)$. **04**

(i) Find the maximum allowable value of the sampling interval, T_s.

(ii) What is the minimum bandwidth of the low pass filter, required to reconstruct the signal without distortion?

(b) State and explain the following properties of the Fourier transform. **08**

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

(c) Find the Fourier transform of each of the following functions: **08**

(i) $x(t) = 1$ (ii) $x(t) = \delta(t)$ (iii) $e^{jw_o t}$ (iv) $x(t) = \cos(w_o t)$

5. (a) (i) Find the impulse response $h[n]$ of the causal discrete-time LTI system satisfying the following difference equation: $y[n] = x[n] + y[n-1]$. **04**

(ii) Show that the above system is unstable.

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

(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) $y(t) = \mathrm{x}(t)\sin 6t$

(c) Consider a continuous-time LTI system described by the first order differential equation $\frac{dy(t)}{dt} + 2y(t) = x(t)$. Using the Fourier transform, find the following: **08**

(i) The frequency response of the system. (ii) The impulse response of the system.

(iii) The step response of the system.