Reg. No.										

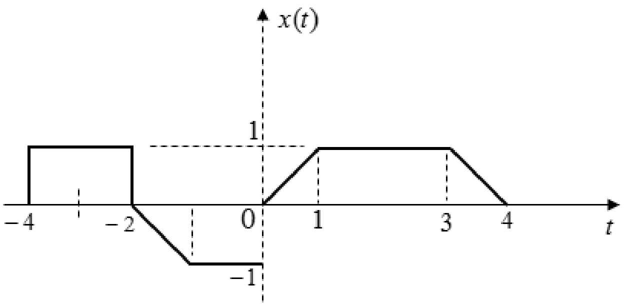
MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

THIRD SEMESTER B.TECH. (E & C) DEGREE END SEMESTER EXAMINATION
July/August 2021
SUBJECT: SIGNALS AND SYSTEMS (ECE - 2155)

TIME: 2 HOURS **MAX. MARKS: 40**

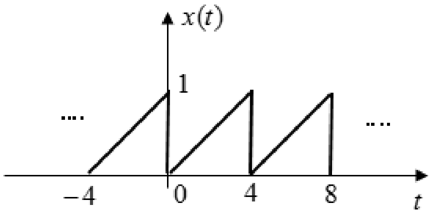
Instructions to candidates
- Answer **Any four full** questions.
- Missing data may be suitably assumed.

1A. Consider the signal x(t) shown in figure below.
i) Obtain and plot even part $x_e(t)$ and odd part $x_o(t)$.
ii) Compute energy of x(t), $x_e(t)$ and $x_o(t)$.



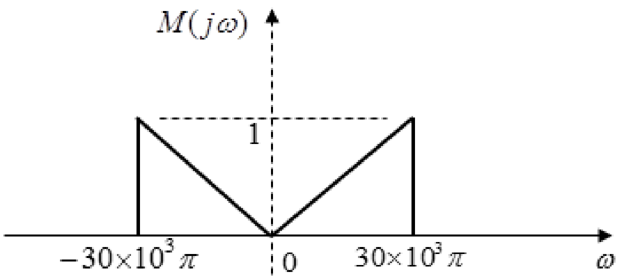
1B. The rectangular pulse is defined as $rect(t) = 1,\ |t| \leq 0.5$
$= 0$ *elsewhere*.

Using this pulse along with ramp signal, generate the following periodic saw-tooth wave.



(5+5)

2A. With mathematical proof, show that that the Fourier Transform of the product of two non-periodic continuous time signals is the convolution between the individual Fourier transforms. Using this concept obtain and plot the spectrum of amplitude modulated signal v(t) = m(t) cos(56000πt) where m(t) is the message signal whose spectrum is as shown below.



2B. i) Using the defining equation, determine discrete time Fourier series coefficients of the signal

$$x(n) = \sum_{m=-\infty}^{\infty} (-1)^m [\delta(n+m) + \delta(n-3m)]$$

ii) Using appropriate properties of the Fourier representations, determine Fourier transform of x(t) = $x_1(t) * x_2(t)$ where $x_1(t) = 2\cos(3\pi t)\dfrac{\sin(\pi t)}{\pi t}$, $x_2(t) = 0.5 + \cos(1.5\pi t) + \cos(2.5\pi t)$ and ***** denotes convolution operation.

(5+5)

3A. Let input to the LTI system having impulse response $h(t) = 4\{u(t) - u(t-2)\}$ be $x(t) = 2\{u(t+2) - u(t-2)\}$. Compute and sketch the output y(t) using convolution.

3B. i) Obtain and sketch the direct form-I and direct form-II implementations for continuous time LTI system defined by,

$$y(t) + 2\frac{dy(t)}{dt} - 4\frac{d^2y(t)}{dt^2} = \frac{dx(t)}{dt}.$$

ii) Determine whether the following systems described by impulse response are stable and causal. (i) $h[n] = n\left(\frac{1}{2}\right)^n u[n]$ (ii) $h(t) = e^{-2|t|}$

(5+5)

4A. Certain LTI system produces an output y[n] = $(1/2)^n\{u[n] - 2u[n-1]\}$ for the input x[n]=$(1/4)^n u[n]$. Determine

i) Frequency response of the system.

ii) Impulse response of the system.

iii) Difference equation description of the system.

4B. A causal LTI system has transfer function $H(s) = \dfrac{s-3}{s+3}$. Determine the input for this system which produces an output y(t) = e^{-2t} u(t). Are any other inputs possible which can produce the same output? If so, determine all such possible inputs.

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5A. The continuous time signal x(t) = $\cos(\omega_o t)$ is sampled (impulse sampling) with sampling interval T=1sec to get the sampled signal $x_\delta(t)$. Sketch the spectrum of the sampled signal for $-7\pi \le \omega \le 7\pi$ when (i) $\omega_o = \pi/2$ (ii) $\omega_o = \pi$ (iii) $\omega_o = 3\pi/2$. In each case mention whether aliasing occurs or not.

5B. i) Consider the discrete-time LTI system described by the difference equation, $y[n] - \frac{1}{2}y[n-1] = x[n] + \frac{1}{2}x[n-1]$. Determine (i) System function and (ii) Impulse response assuming that the system is causal and stable.

ii) Consider a causal and stable discrete-time system having poles $p_1 = \frac{1}{4}$ *and* $p_2 = -\frac{1}{2}$ and a zero at $z_1 = \frac{3}{4}$. Obtain the difference equation and impulse response representations of the system.

(5+5)

6A. Prove that the DTFT of the product of two non- periodic discrete time signals is the convolution between the individual DTFTs. Using this concept illustrate with spectral plot, the effect on spectrum of signal h[n] when truncated in time by multiplying with rectangular window of length M. The signal h[n] has spectrum as given below (assume $\Omega_c > 2\pi/M$).

$$H(e^{j\Omega}) = \begin{matrix} 1, |\Omega| \leq \Omega c \\ 0, elsewhere \end{matrix}$$

6B. i) Using the defining equation, determine time domain signal corresponding to Fourier series coefficients $X(k) = (0.5)^{|k|}$, fundamental frequency $\omega_0 = 0.5$

ii) Using appropriate properties of the Fourier representations, determine inverse discrete time Fourier transform of $X(e^{j\Omega}) = \left(1 + cos(5\Omega)\right)\left(\frac{sin\left(\frac{5\Omega}{2}\right)}{sin\left(\frac{\Omega}{2}\right)}\right)$

(5+5)