Reg. No.

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

IV SEMESTER B.S. DEGREE EXAMINATION - MAY 2016

SUBJECT: SIGNALS AND SYSTEMS [EE 243]

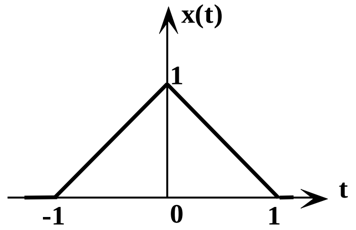
16^{TH} MAY, 2016

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

- ✓ **Answer ANY FIVE Questions.**
- ✓ **Table of transforms can be used**

1A. A triangular pulse signal $x(t)$ is depicted below. Sketch each of the following signals derived from $x(t)$.

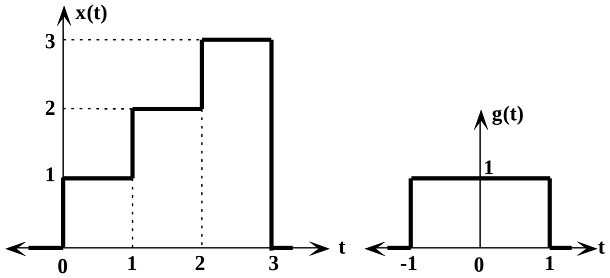
i. $x(3t)$, ii. $x(-2t-1)$, iii. $x(3t)+x(3t+2)$



(6)

1B. Find the inverse Laplace Transform of $X(s) = (4s^2+6)/(s^3+s^2-2)$ **(8)**

1C. Starting with the rectangular pulse $g(t)$ construct the waveform of $x(t)$ and express $x(t)$ in terms of $g(t)$.



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2A. The output $y[n]$ of a LTI system for an impulse input $x[n] = \delta[n]$ is $y[n] = \left\{ \begin{matrix} -2, & 1, & -1, & 2, & 1, & -1, & 2, & 1 \\ & & & \uparrow & & & & \\ & & & n=0 & & & & \end{matrix} \right\}$. Determine the response of the system for the following inputs

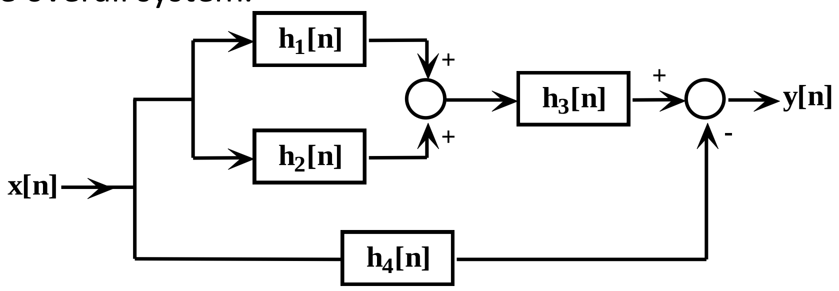
i. $x[n] = \delta[n-2]$, and

ii. $x[n] = \delta[n] - \delta[n-2]$ **(6)**

2B. Find the unilateral Laplace Transform of $x(t) = (-e^{3t}u(t)) * (tu(t))$ **(6)**

2C. Evaluate the convolution integral for a system with input $x(t)$ and impulse response $h(t)$, respectively, given by $x(t) = u(t-1) - u(t-3)$ and $h(t) = u(t) - u(t-2)$. **(8)**

3A. Consider the interconnection of four LTI systems, as shown below. The impulse response of the systems are $h_1[n] = u[n]$, $h_2[n] = u[n+2] - u[n]$, $h_3[n] = \delta[n-2]$, and $h_4[n] = \alpha^n u[n]$. Find the impulse response $h[n]$ of the overall system.



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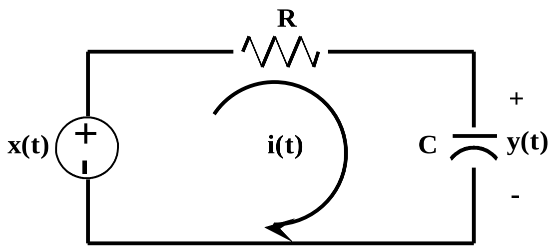
3B. Using the defined equation find the time-domain signal for the given DTFT $X(e^{j\Omega}) = \sin(\Omega) - j\cos(\Omega)$ **(6)**

3C. The impulse response of the RC circuit shown below is $h(t) = \frac{1}{RC} e^{-(t/RC)}\, u(t)$. Find the step response of the circuit.



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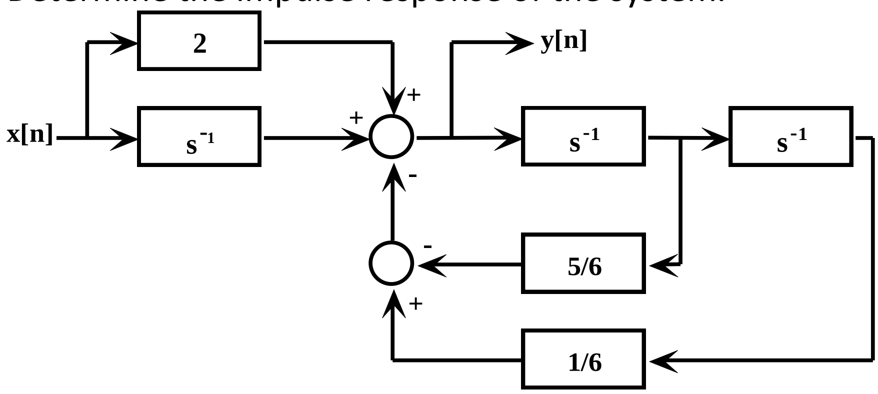
4A. A discrete-time system is represented by block diagram as shown below. Determine the impulse response of the system.



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4B. The transfer function of a LTI system is given by $H(z) = (1 - 2z^{-1} + z^{-2})/(z^{-1} + 0.25z^{-2} - 0.125z^{-3})$. Check the stability and the causality of the system. **(4)**

4C. A LTI system is represented by the difference equation $y[n] - y[n-1] + \frac{2}{9}y[n-2] = x[n-1]$. Using time-domain method determine the zero-input response, zero-state response for an input of $x[n] = \left(\frac{-1}{3}\right)^n u[n]$. The initial conditions are: $y[-1] = -1, \& \; y[-2] = 1$

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5A. For a LTI system the impulse response is $h(t) = 2e^{-3t}u(t)$. Using time-domain method represent the system in differential equation form. **(6)**

5B. The impulse response of a LTI system is given by

$h[n] = 3\left(\frac{2}{3}\right)^n u[n] + 2\left(\frac{1}{2}\right)^{n-2} u[n-1]$. Obtain the difference equation that describes the system using Z-transform. **(8)**

5C. For the given DTFS coefficients $X[k] = \sin\left(\frac{2\pi k}{5}\right)$ determine the corresponding time-signal x[n]. **(6)**

6A. For a LTI system the input $x(t)$ & the output $y(t)$ is respectively given as $x(t) = e^{-t}u(t)$, and $y(t) = (e^{-2t} + 2e^{-3t})u(t)$. Find the frequency response and hence the impulse response of the system using Fourier Transform. **(8)**

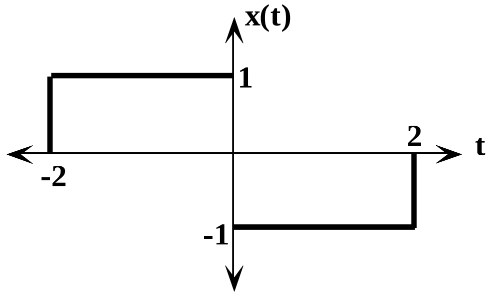
6B. Find the DTFS coefficients of the signal $x[n] = 1 + 3\sin\left(\frac{2\pi n}{3}\right) - \cos\left(\frac{5\pi n}{16}\right)$. Also, plot the phase and magnitude spectrum **(8)**

6C. For each of the following impulse responses, determine whether the corresponding system is **causal** and **stable**. Justify the answers.

i. $h(t) = e^{-2|t|}$

ii. $h[n] = \delta[n] + 2\sin[\pi n]$ **(4)**

7A. Find the Fourier Transform of the following signal



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7B. Determine the Z-transform, the ROC, and the locations of poles and zeros of $X(z)$ for the following signals:

i. $x[n] = \left(\frac{1}{2}\right)^n u[n] + \left(\frac{-1}{3}\right)^n u[n]n$

ii. $x[n] = e^{jn\Omega_0}u[n]$ **(8)**

7C. Using the defining equation find the DTFT of the following signals

i. $x[n] = 2\delta[4 - 2n]$

ii. $x[n] = (1/2)^n u[n-2]$ **(6)**

8A. Determine the transfer function and the impulse response for the causal LTI system described by the difference equation

$y[n] - \frac{1}{4}y[n-1] - \frac{3}{8}y[n-2] = -x[n] + 2x[n-1].$ **(8)**

8B. Consider a LTI system with impulse response $\mathrm{h[n]} = \left(\frac{3}{4}\right)^{\mathrm{n}} \mathrm{u[n]}$. Determine the output $\mathrm{y[n]}$ of the system at times $\mathrm{n} = -5,$ and $\mathrm{n} = 5$ when the input is $\mathrm{x[n]} = \mathrm{u[n]}$. **(6)**

8C. A trapezoidal pulse $\mathrm{x(t)}$ is defined by

$$\mathrm{x(t)} = \begin{cases} \mathrm{t} + 5, & -5 \leq \mathrm{t} \leq -4 \\ 1, & -4 \leq \mathrm{t} \leq 4 \\ -\mathrm{t} + 5, & 4 \leq \mathrm{t} \leq 5 \\ 0, & \text{otherwise} \end{cases}$$

Determine the total energy of $\mathrm{x(t)}$. **(6)**