Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

Course: Signals & Systems **Semester: III**
Program: B Tech ECE/ Mechatronics **Time 03 hrs.**
Course Code: ECEG2010 **Max. Marks: 100**

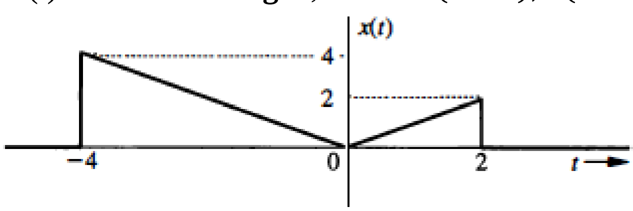
Instructions:

- Attempt all questions as per the instruction.
- Assume any data if required and indicate the same clearly.
- Unless otherwise indicated symbols and notations have their usual meanings.
- Strike off all unused blank pages

SECTION A (20 Marks)

S. No.		Marks	CO
Q 1	Statement the stability and causality of continuous time LTI system. Check stability of continuous-time system having the following impulse responses: $h(t) = te^{-t}u(t)$	**5**	**CO1**
Q 2	Given the relationships y(t) = x(t)*h(t) and z(t) = x(3t)*h(3t) and given that x(t) has the Fourier transform X(ω) and h(t) has the Fourier transform H(ω), use Fourier transform properties to show that z(t) has the form z(t) = Ay(Bt). And also determine the values of A and B	**5**	**CO2**
Q 3	Find the Laplace transform of $$x(t) = \begin{cases} e^{t}\sin(2t); & t \le 0 \\ 0; & t > 0 \end{cases}$$ Indicate the location of its poles and its region of convergence.	**5**	**CO3**
Q 4	Let $x[n] = (-1)^n u[n] + \alpha^n u[n - n_0]$. Determine the constraints on the complex number α and the integer n_0, geiven that the ROC of X(z) is $1 < \|z\| < 2$	**5**	**CO4**

SECTION B (40 Marks)

Q 5	**(a)** For the signal x (t) illustrated in **Fig.1** , sketch $x(t-4); x(2t-4); and\ x(2-t)$  **Fig. 1** **(b)** The unit impulse response of an continuous time LTI system is $h(t) = [2e^{-3t} - e^{-2t}]u(t)$. Find this system's response y (t) in time domain if the input x (t) is $e^{-t}u(t)$	**4+6**	**CO1**
Q 6	**(a)** State sampling theorem. **(b)** Determine the Nyquist rate for the following signals:	**2+3+5**	**CO2**

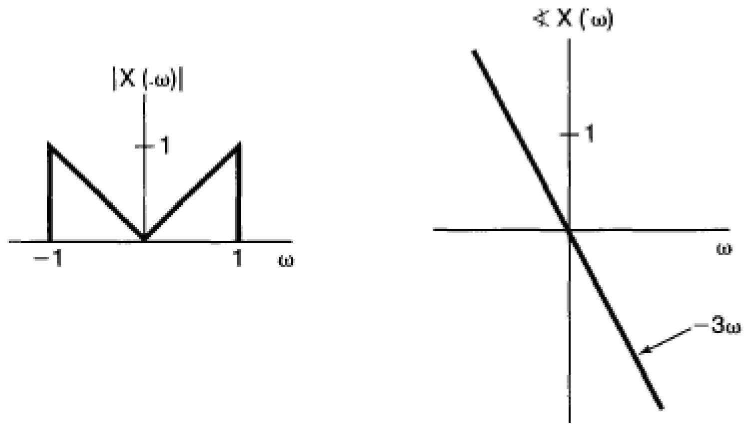
<table>
<tr><td></td><td>(i) $x(t)=\dfrac{\sin 5\pi t}{\pi t}\cos 2\pi t+\dfrac{\sin 2\pi t}{\pi t}\sin 8\pi t$ and (ii) $x(t)=5+7\cos 2\pi t+6\sin^2 8\pi t$
(c) Determine the continuous-time signal corresponding to the following Fourier transform shown in Fig. 2.


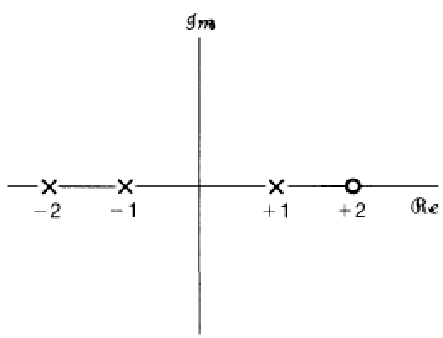
Fig 2(a) Magnitude response (b) Phase response</td><td></td><td></td></tr>
<tr><td>Q 7</td><td>(a) Find the inverse Laplace transform of the following function
$X(s)=\dfrac{2s^2-2s-6}{(s+1)(s-1)(s+2)}$; If Region of Convergence (ROC) is:
(i) Re{s}> 1,
(ii) Re{s}< -2,
(iii) -2< Re{s}< -1 and
(iv) -1< Re{s}< -1
(b) The step response of a certain initially relaxed device is $y(t)=\left(1-\frac{1}{2}e^{-t/3}\right)u(t)$.
Determine the impulse response of the system of two such devices connected in cascade.
OR
(c) Consider an LTI system for which the system function H(s) has the pole-zero pattern shown in Fig. 3


Fig. 3
(i) Indicate all possible ROCs that can be associated with this pole-zero pattern.
(ii) For each ROC identified in part (a), specify whether the associated system stable and/or causal.</td><td>5+5</td><td>CO3</td></tr>
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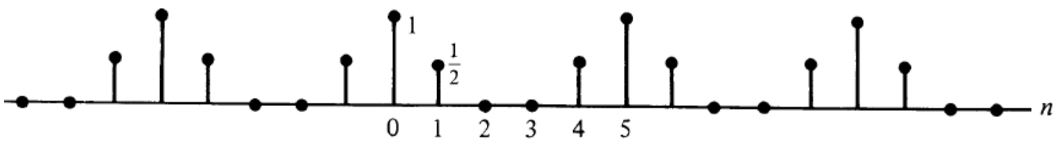
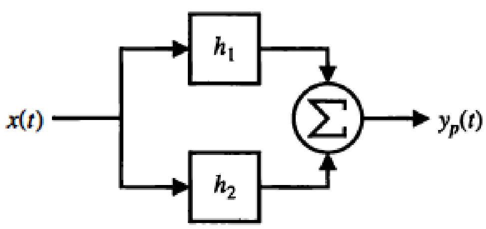
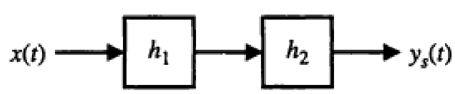
Q 8	**(a)** Determine the convolution of the following pair of the signals by using Z-transform: $x_1[n]=\left(\frac{1}{4}\right)^n u[n-1]$ and $x_2[n]=\left(1+\left(\frac{1}{2}\right)^n\right)u[n]$ **(b)** Find the discrete-time Fourier series for the following periodic signal as shown in **Fig. 4**  **Fig. 4**	**6+4**	**CO4**
	SECTION-C (40 Marks) • **Attempt Q 9 is compulsory** • **Attempt any one from Q10 and Q11**		
Q 9	**(a)** Two LTIC systems have impulse response functions given by $h_1(t) = (1-t)[u(t)-u(t-1)$ and $h_2(t)=t[u(t+2)-u(t-2)$ (i) Carefully sketch the functions $h_1(t)$ and $h_2(t)$. (ii) Assume that the two systems are connected in parallel as shown in **Fig. 5(a)**. carefully plot the equivalent impulse response function, $h_p(t)$. (ii) Assume that the two systems are connected in cascade as shown in **Fig. 5(b)**. carefully plot the equivalent impulse response function, $h_s(t)$.  **Fig. 5(a)**  **Fig. 5(b)** **(b)** The complex exponential Fourier series representation of a signal x(t) over the interval (0,T) is $x(t)=\sum_{n=-\infty}^{\infty}\frac{3}{4+(n\pi)^2}e^{jn\pi t}$. Determine (i) the numerical value of T; (ii) the numerical value of A, if one of the components of x(t) is $A\cos 5\pi t$.	**12+8**	**CO1** **CO2**
Q 10	**(a)** Consider a causal LTI system that is characterized by the difference equation: $y[n]-\frac{3}{4}y[n-1]+\frac{1}{8}y[n-2]=2x[n]$ find the unit impulse response of the system and also determine the output response if $x[n]=\left(\frac{1}{4}\right)^n u[n]$	**10+10**	**CO3**

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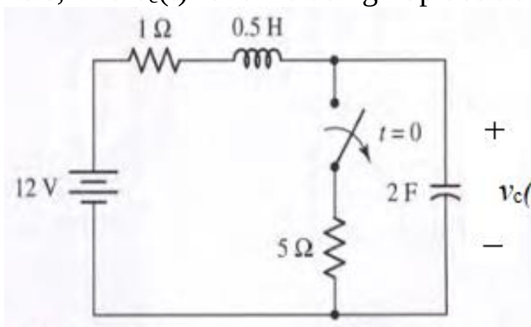
<td>(b) The switch in the circuit shown in Fig. 6 below has been closed for a very long time. If it opens at t = 0 s, find $v_c(t)$ for t > 0 using Laplace transform.


Fig. 6</td>
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<td>CO4</td>
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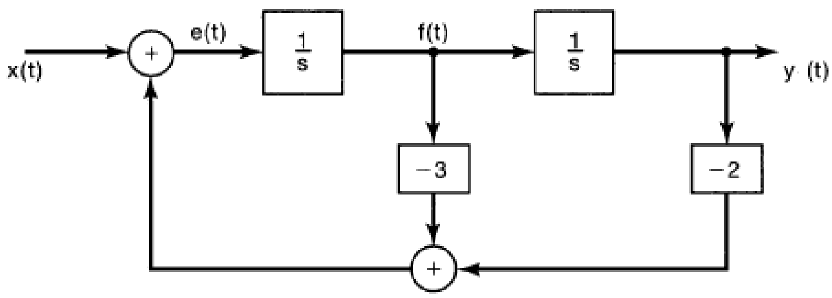
<td>Q 11</td>
<td>(a) The input x(t) and output y(t) of a causal LTI system are related through the block diagram representation shown in Fig. 7
(i) Determine a differential equation relating y(t) and x(t).
(ii) Is this system stable?


Fig. 7
(b) Consider the second order system transfer function: $H(z) = \frac{1}{\left(1+\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)}$
(i) Determine the difference equation of this system
(ii) Draw the block diagram representation of this system.
(iii) check the stability and causality of the system from its impulse response h[n]</td>
<td>10+10</td>
<td>CO3

CO4</td>
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