Name: **Enrolment No:**	UPES

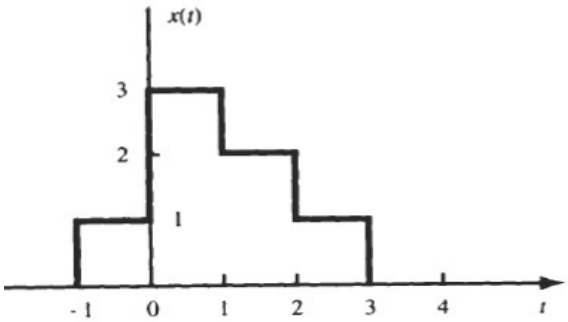
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, April/May 2018

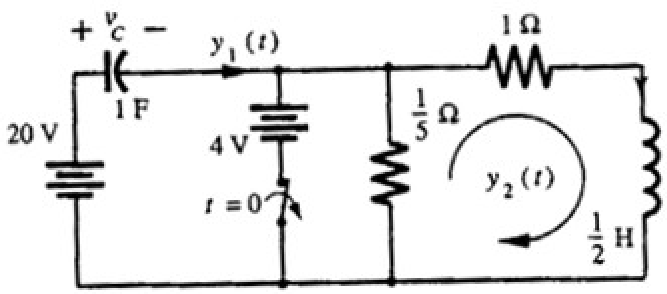
Course: Signals & Systems **Semester: VI**
Program: B Tech Mechatronics
Time: 03 hrs. **Max. Marks: 100**
No. of page/s: 3

Instructions:
- The question paper contains three sections namely Section-A, Section-B and Section-C.
- Attempt all questions. The number of marks for each question is mentioned on the right side of it.
- 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	Determine whether the following signals are periodic or not. If yes find the fundamental time period. $x[n]=(-1)^{n^2}$	**5**	**CO1**
Q 2	**(a)** Define convolution integral and convolution sum. **(b)** Write the properties of the convolution integral	**2+3**	**CO3**
Q 3	Given that $x(t)$ has the Fourier transform $X(\omega)$, express the Fourier transforms of the following signals **(a)** $x_1(t)=x(1-t)+x(-1-t)$ **(b)** $x_2(t)=x(3t-6)$	**3+2**	**CO2**
Q 4	The following facts are given about a real signal x(t) with Laplace transform X(s): (i) X(s) has exactly two poles; (ii) X(s) has no zeros in the finite s-plane (iii) X(s) has a pole at s = -1+j (iv) X(0) = 8 Determine X(s) and specify its ROC	**5**	**CO2**

SECTION B (40 Marks)			
Q 5	**(a)** Determine the Nyquist rate for the following signals: (i) $x(t)=\frac{\sin 5\pi t}{\pi t}\cos 2\pi t+\frac{\sin 2\pi t}{\pi t}\sin 8\pi t$ and (ii) $x(t)=5+7\cos 2\pi t+6\sin^2 8\pi t$ **(b)** Write the equation for the signal depicted in fig. in terms of step function.  **(b)** Let $x(t)$ be a continuous time signal and let $y(t)=x(2t)$, consider the following**:** **if x(t) is periodic, then y(t) is periodic**. For this statement determine whether it is true and if so determine the relationship between the fundamental periods of the two signals.	2+3+5	CO1
Q 6	**(a)** Let $X(e^{j\omega})$ denote the Fourier transform of a discrete signal x[n] depicted in fig. calculate the following values without explicitly evaluating $X(e^{j\omega})$ (i) $X(e^{j0})$; $X(e^{j\pi})$ and $\int_{-\pi}^{\pi} X(e^{j\omega})d\omega$ (ii) $\int_{-\pi}^{\pi} \left\|X(e^{j\omega})\right\|^2 d\omega$ and $\int_{-\pi}^{\pi} \left\|\frac{dX(e^{j\omega})}{d\omega}\right\|^2 d\omega$ **(b)** Find the inverse Z-transform of $X(z)=\frac{1-z^{-1}+z^{-2}}{(1-\frac{1}{2}z^{-1})(1-2z^{-1})(1-z^{-1})}; with\, ROC: 1<\|z\|<2$	5+5	CO2
Q **7**	**(a)** Let the input of the system $x(t)=u(t-3)-u(t-5)$ and impulse response $h(t)=e^{-3t}u(t)$ **.** Compute the output of the system y(t) using convolution integral. **(b)** Consider a causal LTI system that is characterized by the difference equations: $y[n]-\frac{3}{4}y[n-1]+\frac{1}{8}y[n-2]=2x[n]$ *the difference equations: that is circuitsosed fora lor* Find the system transfer function H(z) and the impulse response h[n].	6+4	CO3
Q 8	**(a)** A causal system with impulse response h(t) has its input x(t) and output y(t) relate d through a linear constant coefficient differential equation of the form $\frac{d^3y(t)}{dt^3}+(1+\alpha)\frac{d^2y(t)}{dt^2}+\alpha(1+\alpha)\frac{dy(t)}{dt}+\alpha^2 y(t)=x(t)$ (i) Determine H(s); If $g(t)=\frac{dh(t)}{dt}+h(t)$ how many poles does G(s) have?	6+4	CO3

	(ii) For what real values of the parameter α is the system guaranteed to stable? **(b)** Determine the Z-transform of the sequence $x[n]=n a^n u[n]$		**CO2**
	SECTION-C (40 Marks) **Attempt any two questions from section-c**		
Q 9	**(a)** The switch in the circuit shown in fig. is closed for a long time before t = 0, when it is opened at t = 0, find the currents $i_1(t) \wedge i_1(t) for\, t > 0$. Using Laplace transform method only.  **(b)** Also write the state equation for the above circuits for $for\, t > 0$ (Assume all initial conditions are zero for this part only).	**10+10**	**CO4**
Q 10	**(a)** Consider the system is characterized by the difference equation $\frac{d^2 y(t)}{dt^2}+5\frac{dy(t)}{dt}+6y(t)=-4x(t)-3\frac{dx(t)}{dt}$ Determine the total output response of the system when the input is $x(t)=e^{-4t}u(t)$ and the initial conditions are y ¿ **(b)** A linear time invariant system is characterized by the system function $$H(z)=\frac{3-4z^{-1}}{1-3.5z^{-1}+1.5z^{-2}}$$ Specify the ROC and determine h(n) when (i) the system is stable; (ii) the system is causal	**10+10**	**CO3** **CO4**
Q 11	**(a)** Determine the output response of the system described by the following difference equation $y[n]=\frac{5}{6}y[n-1]-\frac{1}{6}y[n-2]+x[n]$ to the input signal $x[n]=\delta[n]-\frac{1}{3}\delta[n-1] o\, the\, input\, signal\, lowing\, difference\, equation\, input\, currents$ **(b)** The step response of a certain initially relaxed device is $y(t)=\left(1-\frac{1}{2}e^{\frac{-t}{3}}\right)u(t)$. Determine the impulse response of the system of two such devices connected in cascade.	**10+10**	**CO3**

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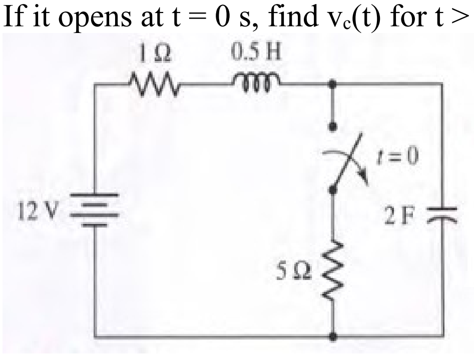
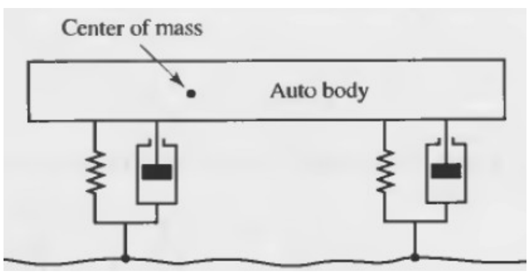
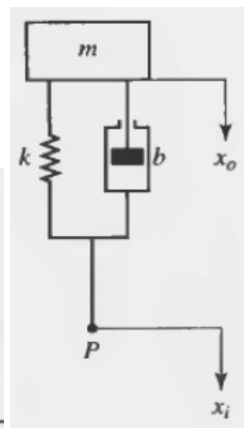
SECTION A (20 Marks)

S. No.		**Marks**	**CO**
Q 1	Determine whether the following system is linear, causal and stable. $$y(t)=x(t)+2x(\sin t)$$ Where x(t) and y(t) are the input and output signals to the system respectively	**5**	**CO1**
Q 2	**(a)** Consider a discrete-time signal $$x[n]=1-\sum_{k=3}^{\infty}\delta(n-1-k)$$ Show that x[n] can be expressed as $x[n]=u[Mn-n_0]$, also determine the values of M and n_0	**5**	**CO1**
Q 3	Find the Fourier transforms of the following signals	**5**	**CO2**

	(a) $x(t) = sgn(t) = \begin{cases} 1; t>0 \\ 0; t=0 \\ -1; t<0 \end{cases}$ **(b)** $x(t) = u(t)$		
Q 4	Find the output response of an LTI discrete time system whose impulse response $h[n] = (2^n + 3(-5)^n)u[n]$ and the input $x[n] = 3^{n+2}u[n]$	**5**	**CO3**
	SECTION B (40 Marks)		
Q 5	**(a)** Let $x(t)$ be a continuous time signal and let $y(t) = x(t/2)$, consider the following: **if x(t) is periodic, then y(t) is periodic**. For this statement determine whether it is true and if so determine the relationship between the fundamental periods of the two signals. **(b)** Determine whether the following signal is power signal or energy signal $x(t) = e^{-a\|t\|}; a>0$	**5+5**	**CO1**
Q 6	**(a)** Determine the DTFT of the following sequences: (i) $x[n] = \{1, -1, 2, 2\}$ (ii) $x[n] = \delta[n-1] + \delta[n+1]$ **(b)** consider a signal y(t) which is related to two signals $x_1(t) \wedge x_2(t)$ by $y(t) = x_1(t-2) * x_2(t-3)$ Where $x_1(t) = e^{-2t}u(t) \wedge x_2(t) = e^{-3t}u(t)$ Using the Laplace transform properties, determine the Laplace transform of y(t)	**4+6**	**CO2**
Q 7	Suppose that the unit impulse response of an LTI system is a unit ramp, $h[n] = nu[n]$. Compute the response of this system by means of convolution sum to a unit step input x[n] = u[n].	**10**	**CO3**
Q 8	The switch in the circuit shown in figure 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.  Also determine the state equation for the above circuit	**10**	**CO4**
	SECTION-C (40 Marks) **Attempt any two questions from section-c**		
Q 9	**(a)** Consider a continuous-time LTI stable system characterized by the following	**10+10**	**CO3**

	differential equation: $\frac{d^2y(t)}{dt^2}+4\frac{dy(t)}{dt}+3y(t)=\frac{dx(t)}{dt}+2x(t)$. Determine the system impulse response h (t). Suppose that the input signal $x(t) = e^{-t}u(t)$, determine the output response y(t). **(b)** Check whether the following systems are causal and stable having the system transfer function **(i)** $H(s)=\frac{1}{s^2+5s+6}$ *when the ROC is* $\Re(s)>-2 \wedge -3<\Re(s) \leftarrow 2$ **(ii)** $H(z)=\frac{-1-0.4z^{-1}}{1-2.8z^{-1}+1.6z^{-2}}$ *when the ROC is* $\lvert z\rvert>2 \wedge \lvert z\rvert<0.8$		
Q 10	**(a)** Consider an automobile suspension system as shown in fig.   Find the system transfer function. Where x_0 and x_i are the output and input to the given suspension system **(b)** A linear time invariant system is characterized by the system function $H(z)=\frac{3-4z^{-1}}{1-3.5z^{-1}+1.5z^{-2}}$ Specify the ROC and determine h(n) when (i) the system is stable; (ii) the system is causal	**10+10**	**CO4**
Q11	**(a)** Consider a causal LTI system that is characterized by the difference equations: $y[n]-\frac{3}{4}y[n-1]+\frac{1}{8}y[n-2]=2x[n]$ *the difference equations : that is circuitsosed fora lor* Find the system transfer function H(z) and the impulse response h[n]. **(b)** Consider a continuous-time LTI system for which the input x(t) and output y(t) are related by the differential equation $\frac{d^2y(t)}{dt^2}-\frac{dy(t)}{dt}-2y(t)=x(t)$ Let X(s) and Y(s) denote the Laplace transform of x(t) and y(t) respectively and H(s) denote the Laplace transform of system impulse response h(t). **(i)** Determine H(s) as the ratio of two polynomials in s. sketch the pole-zero pattern of H(s)	**10+10**	**CO3** **CO4**

	(ii) Determine the impulse response for each of the cases: the system is stable; the system is causal; and the system is neither stable nor causal.		