K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE - 560109

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

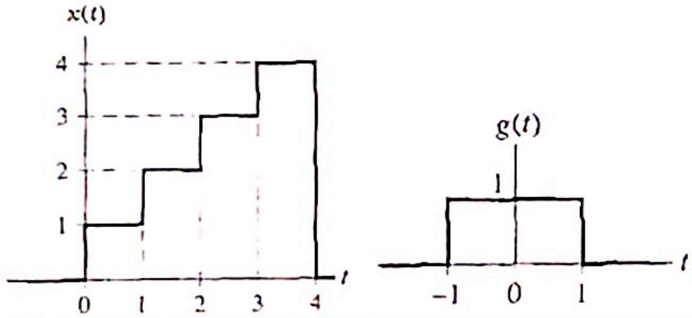
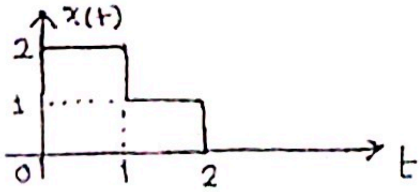
I SESSIONAL TEST QUESTION PAPER 2019 – 20 ODD SEMESTER

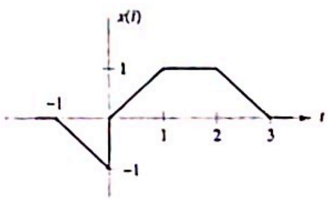
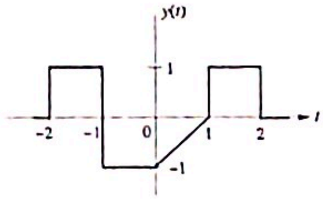
SET-A

USN										

Degree	: B.E		Semester	:	V
Branch	: Electrical and Electronics Engineering		Date	:	4-9-2019
Course Title	: Signals and Systems		Course Code	:	15EE54/17EE54
Duration	: 90 Minutes		Max Marks	:	30

Note: Answer ONE full question from each part

Q. No.	Question	Marks	K Level	CO mapping
	PART-A			
1(a)	Explain classification of signals .	5	Understanding K2	CO1
(b)	Two signals x(t) and g(t) are shown. Sketch signal x(t) in terms of g(t). 	5	Applying K3	CO1
(c)	A continuous time LTI system is represented by the impulse response $h(t) = e^{-3t}u(t-1)$. Determine whether it is (i) Memory less (ii) Causal and (iii) stable.	5	Applying K3	CO2
	OR			
2(a)	Differentiate between power and energy signal.	5	Understanding K2	CO1
(b)	Sketch the following signals for given signal x(t). (i) $x(2(t-2))$ (ii) $x(2t-1)$ 	5	Applying K3	CO1

(c)	Find the step response for the LTI system represented by the impulse response $$h(n) = \left(\frac{1}{2}\right)^n u(n)$$	5	Applying K3	CO2
PART-B				
3(a)	Determine whether the following systems are linear, time variant, causal, memory less and stable. $$y(t) = x^2(t)$$	5	Applying K3	CO1
(b)	Determine whether the following signals are periodic, if periodic determine the fundamental period $$x[n] = \cos\left(\frac{n\pi}{5}\right)\sin\left(\frac{n\pi}{3}\right)$$	5	Applying K3	CO1
(c)	Find convolution of two finite duration sequences $h(n) = a^n u(n)$ for all n and $x(n) = b^n u(n)$ for all n when $a \neq b$	5	Applying K3	CO2
OR				
4(a)	Sketch x(t)y(t-1) for given signal x(t) and y(t).  	5	Applying K3	CO1
(b)	Sketch the signal $x(t) = -u(t+3) + 2u(t+1) - 2u(t-1) + u(t-3)$	5	Applying K3	CO1
(c)	Find the convolution integral of $x_1(t) = e^{-2t}u(t)$ and $x_2(t) = u(t+2)$	5	Applying K3	CO2

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Course In charge

Head - Dept

K. Rao

Principal

K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE - 560109

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

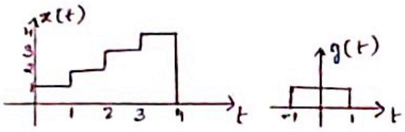
I SESSIONAL TEST SCHEME & SOLUTION 2019 – 20 ODD SEMESTER

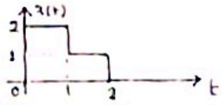
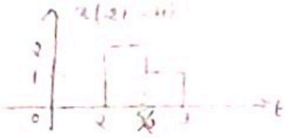
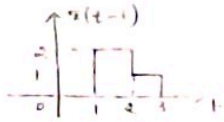
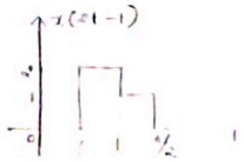
SET-A

USN										

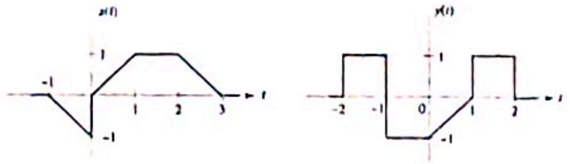
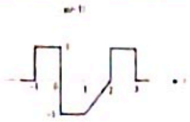
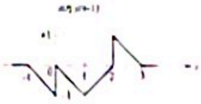
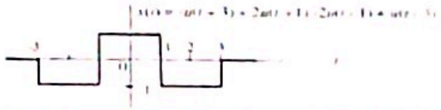
Degree	:	**B.E**	**Semester**	:	**V**
Branch	:	**Electrical and Electronics Engineering**	**Date**	:	**4-9-2019**
Course Title	:	**Signals and Systems Systems**	**Course Code**	:	**15EE54 /17EE54**
Duration	:	**90 Minutes**	**Max Marks**	:	**30**

Note: Answer ONE full question from each part

Q. No.	Questions with Scheme & Solution	Marks	K Level	CO mapping
	PART-A			
1(a)	Explain classification of signals.	5	K2 Understanding	CO1
Sol	(a) Periodic and non-periodic signal (b) Odd and even signal (c) Energy and power signal (d) Deterministic and random signal (d) Causal and non-causal signal	1 1 1 1 1		
(b)	Two signals x(t) and g(t) are shown. **Sketch** signal x(t) in terms of g(t). 	5	K3 Applying	CO1
Sol	$g_1(t) = g(\frac{t}{2} - 1)$ $g_2(t) = g(\frac{2t}{3} - \frac{5}{3})$ $g_3(t) = g(t-3)$ $g_4(t) = g(2t-7)$ $x(t) = g_1(t) + g_2(t) + g_3(t) + g_4(t)$ $x(t) = g\left(\frac{t}{2} - 1\right) + g\left(\frac{2t}{3} - \frac{5}{3}\right) + g(t-3) + g(2t-7)$	1 1 1 1 1		
(c)	A continuous time LTI system is represented by the impulse response $h(t) = e^{-3t}u(t-1)$ **Determine** whether it is (i) Memory less (ii) Causal and (iii) stable	5	K3 Applying	CO2

Sol	$$\int_{-\infty}^{\infty} h(\tau)d\tau = \int_{-1}^{\infty} e^{-3\tau}d\tau$$ $\int_{-\infty}^{\infty} h(\tau)d\tau = \frac{e^{-3}}{3} < \infty$ System is stable. System is causal. System is with memory.	1 1 1 1 1		
	OR			
2(a)	**Differentiate** between power and energy signal.	5	K2 Understanding	CO1
Sol	Any Five differences between power and energy signals. Each difference carries one mark each.	1*5=5		
(b)	**Sketch** the following signals for given signal x(t). (i) $x(2(t-2))$ (ii) $x(2t-1)$ 	5	K3 Applying	CO1
Sol	  	2 1 2		
(c)	**Find** the step response for the LTI system represented by the impulse response $$h(n) = \left(\frac{1}{2}\right)^n u(n)$$	5	K3 Applying	CO2
Sol	$$S[n] = \sum_{k=-\infty}^{n} h(k)$$ for n<0 . S[n]=0 for $n \geq 0$, $$S[n] = \sum_{k=0}^{n} \left(\frac{1}{2}\right)^k$$	1 1 1		

	$$S[n] = 2\left[1-\left(\frac{1}{2}\right)^{n+1}\right]u[n]$$	2		
	PART-B			
3(a)	**Determine** whether the following systems are linear, time variant, causal, memory less and stable. $$y(t) = x^2(t)$$	5	K3 Applying	CO1
Sol	<u>Linearity</u> $y_3(t) \neq ay_1(t) + by_2(t)$ Therefore the system is **nonlinear.** <u>Time invariance</u> $y(t,T) = y(t-T)$ The system is **Time invariant.** <u>Causality:</u> Since the output of the system is not depending on the future value of the input, the system is **Causal.** <u>Memory:</u> Output of the system is not depending on the past value of the input. Therefore the system is **Memory less.** <u>Stability</u>: If the input of the system is bounded, then output of the system also bounded. Therefore it is a **Stable** system.	1 1 1 1 1		
(b)	**Determine** whether the following signals are periodic, if periodic determine the fundamental period $$x[n] = \cos\left(\frac{n\pi}{5}\right)\sin\left(\frac{n\pi}{3}\right)$$	5	K3 Applying	CO1
Sol	$N = \frac{\Omega}{2\pi}$ $N_1 = \frac{15}{4}$ $N_2 = 15$ $\frac{N_1}{N_2} = \frac{1}{4}$ signal is **periodic** $N_0 = 15\ samples$	1 1 1 1 1		
(c)	**Find** convolution of two finite duration sequences $h(n) = a^n u(n)$ for all n and $x(n) = b^n u(n)$ for all n when $a \neq b$	5	K3 Applying	CO2
Sol	$y[n] = \sum_{k=-\infty}^{\infty} x[k]h[n-k]$ $y[n] = \sum_{k=-\infty}^{\infty} b^k u(k) a^{n-k} u(n-k)$ $= \sum_{k=0}^{n} b^k a^{n-k}$ $y[n] = \frac{a^{n+1} - b^{n+1}}{a-b}$	1 1 1 2		
	OR			
4(a)	**Sketch** x(t)y(t-1) for given signal x(t).	5	K3 Applying	CO1

				
Sol	 	2 3		
(b)	Sketch the signal $x(t) = -u(t+3) + 2u(t+1) - 2u(t-1) + u(t-3)$	5	K3 Applying	CO1
Sol	Sketching $u(t+3)$ Sketching $u(t+1)$ Sketching $u(t-3)$ Sketching $u(t-1)$ 	1 1 1 1 1		
(c)	Find the convolution integral of $x_1(t) = e^{-2t}u(t)$ and $x_2(t) = u(t+2)$	5	K3 Applying	CO2
Sol	$Y(t) = x_1(t) * x_2(t)$ $y(t) = \int_{-\infty}^{\infty} x_1(\tau)x_2(t-\tau)d\tau$ $y(t) = 0; t < -2$ $y(t) = \int_{0}^{t+2} e^{-2\tau}d\tau$ $y(t) = \frac{1}{2}\left[1 - e^{-2(t+2)}\right] \quad t \geq -2$	1 1 1 2		

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

II SESSIONAL TEST QUESTION PAPER 2019 – 20 ODD SEMESTER

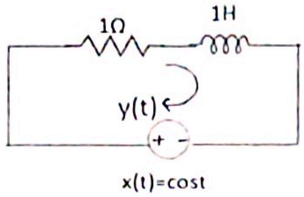
SET-A

USN										

Degree	: B.E		Semester	:	V
Branch	: Electrical and Electronics Engineering		Date	:	16-10-2019
Course Title	: Signals and Systems		Course Code	:	15EE54 / 17EE54
Duration	: 90 Minutes		Max Marks	:	30

Note: Answer ONE full question from each part

Q. No.	Question	Marks	K Level	CO mapping
	PART-A			
1(a)	Determine the natural response for the system described by the following differential equation. $\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = 2x(t) + \frac{dx(t)}{dt}$; $y(0) = 3, \left.\frac{dy(t)}{dt}\right\vert_{t=0} = -7$	5	K3 Applying	CO2
(b)	Determine the z-transform, the ROC, and the locations of poles and zeros of X(z) for the following signal. $x[n] = \left(\frac{1}{2}\right)^n u[n] + \left(\frac{-1}{3}\right)^n u[n]$	5	K3 Applying	CO3
(c)	State and prove differentiation property of the Z transform.	5	K3 Applying	CO3
	OR			
2(a)	Draw direct form I and direct form II implementation for the system described by $y[n] - \frac{1}{4}y[n-1] - \frac{1}{5}y[n-2] = x[n] + 2x[n-1] + 3x[n-2]$	5	K3 Applying	CO2
(b)	Obtain the time domain signal corresponding to the following z-transform using partial fraction expansion method. $X(z) = \frac{1 + \frac{7}{6}z^{-1}}{(1 - \frac{1}{2}z^{-1})(1 + \frac{1}{3}z^{-1})}$; $\frac{1}{3} < \vert z\vert < \frac{1}{2}$	5	K3 Applying	CO3
(c)	Determine the input to the system if the output and impulse response are given by $y[n] = \frac{1}{3}u[n] + \frac{2}{3}\left(\frac{-1}{2}\right)^n u[n]$ $h[n] = \left(\frac{1}{2}\right)^n u[n]$	5	K3 Applying	CO3

PART-B				
3(a)	Find the forced response of electrical system shown in figure. 	5	K3 Applying	CO2
(b)	Determine the impulse response of the system, $x[n] = \delta[n] + \frac{1}{4}\delta[n-1] - \frac{1}{8}\delta[n-2]$, $y[n] = \delta[n] - \frac{3}{4}\delta[n-1]$	5	K3 Applying	CO3
(c)	Find the Z transform of the following signal using appropriate properties. $x[n] = n\left(\frac{1}{2}\right)^n u[n] \cdot \left(\frac{1}{2}\right)^n u[n]$	5	K3 Applying	CO3
OR				
4(a)	Draw the direct form I and direct form II implementation of the following system $2\dot{y}(t) - 3\ddot{y}(t) = 4x(t) - 3\dot{x}(t) + \ddot{x}(t)$	5	K3 Applying	CO2
(b)	State and prove time reversal property of the Z transform.	5	K3 Applying	CO3
(c)	Using appropriate properties find the z-transform of the following signal. $x[n] = n\sin\left(\frac{\pi}{2}n\right) u[-n]$	5	K3 Applying	CO3

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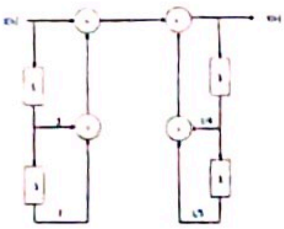
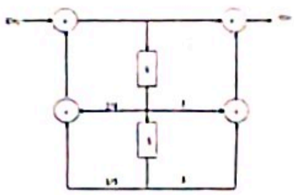
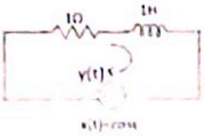
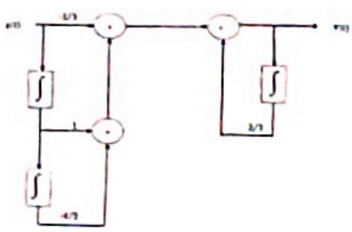
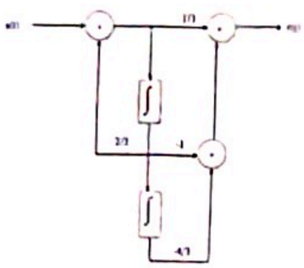
Q. No.	Questions with Scheme & Solution	Marks	K Level	CO mapping
	PART-A			
1(a)	**Determine** the natural response for the system described by the following differential equation. $\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = 2x(t) + \frac{dx(t)}{dt}$; $y(0) = 3, \left.\frac{dy(t)}{dt}\right\|_{t=0} = -7$	5	K3 Applying	CO2
Sol	Characteristic equation $\lambda^2 + 5\lambda + 6 = 0$ $\lambda_1 = -2$, $\lambda_2 = -3$ $y^n(t) = C_1e^{-2t} + C_2e^{-3t}$ $C_1 = 2$ and $C_2 = 1$ $y^n(t) = 2e^{-2t} + e^{-3t}$; $t \geq 0$	1 1 1 1 1		
(b)	**Determine** the z-transform, the ROC, and the locations of poles and zeros of X(z) for the following signal. $x[n] = \left(\frac{1}{2}\right)^n u[n] + \left(\frac{-1}{3}\right)^n u[n]$	5	K3 Applying	CO3
Sol	$X_1[z] = \frac{z}{z-\frac{1}{2}}$; $\|z\| > \frac{1}{2}$ and $X_2[z] = \frac{z}{z+\frac{1}{3}}$; $\|z\| > \frac{1}{3}$ $X[z] = \frac{2z\left(z-\frac{1}{12}\right)}{\left(z-\frac{1}{2}\right)\left(z+\frac{1}{3}\right)}$; $\|z\| > \frac{1}{2}$ Poles are located at $z = \frac{1}{2}$ and $z = -\frac{1}{3}$ Zeros are located at $z = 0$ and $z = \frac{1}{12}$ ROC is $\|z\| > \frac{1}{2}$	1 1 1 1 1		
(c)	State and prove the differentiation property of the Z transform.	5	K3 Applying	CO3
Sol	If $x[n] \overset{z}{\leftrightarrow} X[z]$ with ROC R. then $nx[n] \overset{z}{\leftrightarrow} -z\frac{dX(z)}{dz}$ with ROC R. Proof:	1		

	$Z\{x[n]\}=X[z]=\sum_{n=-\infty}^{\infty} x[n]z^{-n}$ $\frac{dX(z)}{dz}=\sum_{n=-\infty}^{\infty}(-n)x[n]z^{-n-1}$ $\frac{dX(z)}{dz}=-z^{-1}\sum_{n=-\infty}^{\infty}(n)x[n]z^{-n}$ $Z\{nx(n)\}=-Z\frac{dX(z)}{dz}$	1 1 1 1		
	OR			
2(a)	**Draw** the direct form I and direct form II implementation for the system described by $y[n]-\frac{1}{4}y[n-1]-\frac{1}{5}y[n-2]=x[n]+2x[n-1]+3x[n-2]$	5	K3 Applying	CO2
Sol	Direct form I:  Direct form II: 	2.5 + 2.5		
(b)	**Obtain** the time domain signal corresponding to the following z-transform using partial fraction expansion method. $X(z)=\frac{1+\frac{7}{6}z^{-1}}{(1-\frac{1}{2}z^{-1})(1+\frac{1}{3}z^{-1})}\ ;\ \frac{1}{3}<\lvert z\rvert<\frac{1}{2}$	5	K3 Applying	CO3
Sol	$\frac{X(z)}{z}=\frac{z+\frac{7}{6}}{(z-\frac{1}{2})(z+\frac{1}{3})}$ $\frac{X(z)}{z}=\frac{A}{(z-\frac{1}{2})}+\frac{B}{(z+\frac{1}{3})}$ $A=2$ and $B=-1$ $X(z)=2\left(\frac{z}{\left(z-\frac{1}{2}\right)}\right)-\left(\frac{z}{\left(z+\frac{1}{3}\right)}\right)$ $x[n]=-2\left(\frac{1}{2}\right)^{n}u[-n-1]-\left(\frac{-1}{3}\right)^{n}u[n]$	1 1 1 1 1		
(c)	A system has impulse response $h[n]=\left(\frac{1}{2}\right)^{n}u[n]$.**Determine** the input to the system if the output is given by $y[n]=\frac{1}{3}u[n]+\frac{2}{3}\left(\frac{-1}{2}\right)^{n}u[n]$	5	K3 Applying	CO3

Sol	$H[z] = \dfrac{z}{z-\frac{1}{2}}$ $Y[z] = \dfrac{z\left(z-\frac{1}{2}\right)}{(z-1)\left(z+\frac{1}{2}\right)}$ $\dfrac{X[z]}{z} = \dfrac{A}{z} + \dfrac{B}{(z-1)} + \dfrac{C}{\left(z+\frac{1}{2}\right)}$ $A = \frac{-1}{2}\ ,\ B = \frac{1}{6},\ C = \frac{4}{3}$ $x[n] = \dfrac{-1}{2}\delta[n] + \dfrac{1}{6}(1)^n u[n] + \dfrac{4}{3}\left(\dfrac{-1}{2}\right)^n u[n]$	1 1 1 1 1		
	PART-B			
3(a)	Find the forced response of electrical system shown in figure.  	5	K3 Applying	CO2
Sol	$\dfrac{dy(t)}{dt} + y(t) = cost$ $y^n(t) = C_1 e^{-t}$ $y^f(t) = C_1 e^{-t} + \frac{1}{2}cost + \frac{1}{2}sint$ $C_1 = -\frac{1}{2}$ $y^f(t) = -\frac{1}{2}e^{-t} + \frac{1}{2}cost + \frac{1}{2}sint$	1 1 1 1 1		
(b)	Determine the impulse response of the system. $x[n] = \delta[n] + \frac{1}{4}\delta[n-1] - \frac{1}{8}\delta[n-2]$, $y[n] = \delta[n] - \frac{3}{4}\delta[n-1]$	5	K3 Applying	CO3
Sol	$X[z] = 1 + \frac{1}{4}z^{-1} - \frac{1}{8}z^{-2}$ $Y[z] = 1 - \frac{3}{4}z^{-1}$ $H[z] = \dfrac{z^2 - \frac{3}{4}z}{\left(z-\frac{1}{4}\right)\left(z+\frac{1}{2}\right)}$ $H[z] = \dfrac{-2}{3}\left[\dfrac{z}{\left(z-\frac{1}{4}\right)}\right] + \dfrac{5}{3}\left[\dfrac{z}{\left(z+\frac{1}{2}\right)}\right]$ $h(n) = \dfrac{-2}{3}\left(\dfrac{1}{4}\right)^n u[n] + \dfrac{5}{3}\left(\dfrac{-1}{2}\right)^n u[n]$	1 1 2 1		
(c)	Find the Z transform of the following signal using appropriate properties.	5	K3 Applying	CO3

	$x[n] = n\left(\frac{1}{2}\right)^n u[n] * \left(\frac{1}{2}\right)^n u[n]$			
Sol	$\left(\frac{1}{2}\right)^n u[n] \overset{z}{\leftrightarrow} \frac{z}{z-\frac{1}{2}};\ \lvert z\rvert > \frac{1}{2}.$ $n\left(\frac{1}{2}\right)^n u[n] \overset{z}{\leftrightarrow} \frac{\frac{z}{2}}{\left(z-\frac{1}{2}\right)^2};\ \lvert z\rvert > \frac{1}{2}$ $n\left(\frac{1}{2}\right)^n u[n] * \left(\frac{1}{2}\right)^n u[n] \overset{z}{\leftrightarrow} \frac{z^2}{2\left(z-\frac{1}{2}\right)^3};\ \lvert z\rvert > \frac{1}{2}$	1 2 2		
	OR			
4(a)	Draw the direct form I and direct form II implementation of the following system $2\dot{y}(t) - 3\ddot{y}(t) = 4x(t) - 3\dot{x}(t) + \ddot{x}(t)$	5	K3 Applying	CO2
Sol	Direct form I:  Direct form II: 	2.5 + 2.5		
(b)	State and prove the time reversal property of the Z transform	5	K3 Applying	CO3
Sol	If $x[n] \overset{z}{\leftrightarrow} X[z]$ with ROC R, then $x[-n] \overset{z}{\leftrightarrow} X[\frac{1}{z}]$ with ROC $\frac{1}{R_x}$ Proof: $Z\{x[n]\}=X[z]=\sum_{n=-\infty}^{\infty} x[n]z^{-n}$ $Z\{x[-n]\}=\sum_{n=-\infty}^{\infty} x[-n]z^{-n}$ Put l=-n $Z\{x[-n]\}=\sum_{l=-\infty}^{\infty} x[l](z^{-1})^{-l}= X(\frac{1}{z})$	1 1 1 2		
(c)	Using appropriate properties find the z-transform of the following signal. $x[n] = n\sin\left(\frac{\pi}{2}n\right)u[-n]$	5	K3 Applying	CO3
Sol	$Z\{\sin\left(\frac{\pi}{2}n\right)u[n]\} = \frac{z\sin(\frac{\pi}{2}n)}{z^2-2z\cos\frac{\pi}{2}+1} = \frac{z}{z^2+1};\ \lvert z\rvert > 1$ $Z\{\sin\left(-\frac{\pi}{2}n\right)u[-n]\} = \frac{z}{z^2+1};\ \lvert z\rvert < 1$ $Z\{-n\sin\left(-\frac{\pi}{2}n\right)u[-n]\} = \frac{z(1-z^2)}{(z^2+1)^2};\ \lvert z\rvert < 1$	1 2 2		

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K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE - 560109

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III SESSIONAL TEST QUESTION PAPER 2019 – 20 ODD SEMESTER

SET-A

USN										

Degree	: B.E		Semester	:	V
Branch	: Electrical and Electronics Engineering		Date	:	25-11-2019
Course Title	: Signals and Systems		Course Code	:	15EE54 / 17EE54
Duration	: 90 Minutes		Max Marks	:	30

Note: Answer ONE full question from each part

Q. No.	Question	Marks	K Level	CO mapping
	PART-A			
1(a)	Find the inverse Fourier transform of $$X(jw) = \frac{5jw + 12}{(jw)^2 + 5jw + 6}$$	5	Applying K3	CO4
(b)	Find the Fourier transform of the following signal $x(t) = u(t+1) - u(t-1)$	5	Applying K3	CO4
(c)	State and prove convolution property of DTFT.	5	Applying K3	CO5
	OR			
2(a)	State and prove time differentiation property of CTFT.	5	Applying K3	CO4
(b)	Find the Fourier transform of the signal using appropriate properties. $x(t) = \sin(\pi t) e^{-2t} u(t)$	5	Applying K3	CO4
(c)	Find the discrete time Fourier transform of the following signal $x[n] = 2^n u[-n]$	5	Applying K3	CO5
	PART-B			
3(a)	Prove that if $x(t) \overset{FT}{\leftrightarrow} X(jw)$ then $\int_{-\infty}^{t} x(\tau)d\tau \overset{FT}{\leftrightarrow} \frac{X(Jw)}{Jw} + \pi X(j0)\delta(w)$	5	Applying K3	CO4
(b)	The impulse response of a continuous time LTI system is given by $h(t) = \frac{1}{RC} e^{\frac{-t}{RC}} u(t)$ Find the frequency response and draw its spectrum.	5	Applying K3	CO4

(c)	Obtain the frequency response and impulse response of the system described by the difference equation $y[n] - \frac{1}{4}y[n-1] - \frac{1}{8}y[n-2] = 3x[n] - \frac{3}{4}x[n-1].$	5	Applying K3	CO5
OR				
4(a)	Find the time domain expression for the following $X(jw) = \frac{2jw+1}{(2+jw)^2}$	5	Applying K3	CO4
(b)	Find the frequency response and the impulse response of the system described by differential equation $\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = 4\frac{dx(t)}{dt} + x(t)$	5	Applying K3	CO4
(c)	State and prove frequency shift property of DTFT.	5	Applying K3	CO5

5

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K.S. SCHOOL OF ENGINEERING AND MANAGEMENT, BANGALORE - 560109

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

III SESSIONAL TEST SCHEME & SOLUTION 2019 – 20 ODD SEMESTER

SET-A

USN										

Degree	:	B.E	Semester	:	V
Branch	:	Electrical and Electronics Engineering	Date	:	25-11-2019
Course Title	:	Signals and Systems	Course Code	:	15EE54 /17EE54
Duration	:	90 Minutes	Max Marks	:	30

Note: Answer ONE full question from each part

Q. No.	Questions with Scheme & Solution	Marks	K Level	CO mapping
	PART-A			
1(a)	Find the inverse Fourier transform of $X(jw) = \frac{5jw + 12}{(jw)^2 + 5jw + 6}$	5	Applying K3	CO4
Sol	$X(jw) = \frac{A}{(jw+2)} + \frac{B}{(jw+3)}$ $A = 2$ $B = 3$ $X(jw) = \frac{2}{(jw+2)} + \frac{3}{(jw+3)}$ $x(t) = 2e^{-2t}u(t) + 3e^{-3t}u(t)$	1 1 1 1 1		
(b)	Find the Fourier transform of the following signal $x(t) = u(t+1) - u(t-1)$	5	Applying K3	CO4
Sol	$x(t) = \begin{cases} 1; -1 \leq t \leq 1 \\ 0; otherwise \end{cases}$ $X(jw) = \int_{-\infty}^{\infty} x(t)e^{-Jwt}\,dt$ $X(jw) = \int_{-1}^{1} 1.e^{-Jwt}\,dt$ $X(jw) = \frac{1[e^{-Jw} - e^{Jw}]}{-jw}$ $X(jw) = \frac{2sinw}{w}$	1 1 1 1 1		
(c)	State and prove convolution property of DTFT.	5	Applying K3	CO5
Sol	$If\ x[n] \overset{DTFT}{\longleftrightarrow} X(e^{J\Omega})$ $y[n] \overset{DTFT}{\longleftrightarrow} Y(e^{J\Omega})$ Then	1		

	$x[n] * y[n] \xleftrightarrow{DTFT} X(e^{j\Omega})\, Y(e^{j\Omega})$ Proof: $X(e^{j\Omega}) = \sum_{n=-\infty}^{\infty} x[n]e^{-j\Omega n}$ $Y(e^{j\Omega}) = \sum_{n=-\infty}^{\infty} y[n]e^{-j\Omega n}$ $DTFT\{x[n] * y[n]\} = \sum_{n=-\infty}^{\infty} (x[n] * y[n])\, e^{-j\Omega n}$ $= \sum_{n=-\infty}^{\infty} \left[\sum_{l=-\infty}^{\infty} x[l]y[n-l]\right] e^{-j\Omega n}$ $= \sum_{l=-\infty}^{\infty} x[l]\, e^{-j\Omega l} \left[\sum_{m=-\infty}^{\infty} y[m]\right] e^{-j\Omega m}$ $= X(e^{j\Omega})\, Y(e^{j\Omega})$	1 1 1 1		
	OR			
2(a)	**State and prove time differentiation property of CTFT.**	**5**	**Applying K3**	**CO4**
Sol	$If\ x(t) \overset{FT}{\leftrightarrow} X(jw)$ $then\ \frac{dx(t)}{dt} \overset{FT}{\leftrightarrow} jwX(jw)$ Proof: $x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(jw)e^{jwt}\, dw$..................(a) $\frac{dx(t)}{dt} = \frac{d}{dt}[\frac{1}{2\pi}\int_{-\infty}^{\infty} X(jw)e^{jwt}\, dw]$ $\frac{dx(t)}{dt} = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(jw)jwe^{jwt}\, dw$ $\frac{dx(t)}{dt} = \frac{1}{2\pi}\int_{-\infty}^{\infty} [X(jw)jw]e^{jwt}\, dw$...............(b) $From\ (a) and\ (b)$ $\frac{dx(t)}{dt} \overset{FT}{\leftrightarrow} jwX(jw)$	1 1 1 1 1		
(b)	**Find the Fourier transform of the signal using appropriate properties.** $x(t) = \sin(\pi t)e^{-2t}u(t)$	**5**	**Applying K3**	**CO4**
Sol	$x(t) = \left[\frac{e^{j\pi t} - e^{-j\pi t}}{2j}\right] e^{-2t}u(t)$	1		

	$e^{-2t}u(t) \overset{FT}{\leftrightarrow} \frac{1}{2+jw}$ Using frequency shifting property, $e^{j\pi t}e^{-2t}u(t) \overset{FT}{\leftrightarrow} \frac{1}{2+j(w-\pi)}$ Using linearity property, $\frac{1}{2j}e^{j\pi t}e^{-2t}u(t) \overset{FT}{\leftrightarrow} \frac{1}{2j}\frac{1}{2+j(w-\pi)}$ Similarly, $\frac{1}{2j}e^{-j\pi t}e^{-2t}u(t) \overset{FT}{\leftrightarrow} \frac{1}{2j}\frac{1}{2+j(w+\pi)}$ $X(jw) = \frac{1}{j2}\left[\frac{1}{2+j(w-\pi)} - \frac{1}{2+j(w+\pi)}\right]$	1 1 1 1		
(c)	Find the discrete time Fourier transform of the following signal $x[n] = 2^n u[-n]$	5	Applying K3	CO5
Sol	$X(e^{j\Omega}) = \sum_{n=-\infty}^{\infty} x(n)e^{-j\Omega n}$ $X(e^{j\Omega}) = \sum_{n=-\infty}^{0} 2^n e^{-j\Omega n}$ $X(e^{j\Omega}) = \sum_{m=0}^{\infty} (2^{-1}e^{j\Omega})^m$ $X(e^{j\Omega}) = \frac{2}{2-e^{j\Omega}}$	1 1 2 1		
	PART-B			
3(a)	Prove that if $x(t) \overset{FT}{\leftrightarrow} X(jw)$ then $\int_{-\infty}^{t} x(\tau)d\tau \overset{FT}{\leftrightarrow} \frac{X(jw)}{jw} + \pi X(j0)\delta(w)$	5	Applying K3	CO4
Sol	$x_1(t) * x_2(t) = \int_{-\infty}^{\infty} x_1(\tau)x_2(t-\tau)d\tau$ $x(t) * u(t) = \int_{-\infty}^{\infty} x(\tau)u(t-\tau)d\tau$ $x(t) * u(t) = \int_{-\infty}^{t} x(\tau)d\tau$ $FT\left\{\int_{-\infty}^{t} x(\tau)d\tau\right\} = FT\{x(t) * u(t)\}$ $FT\left\{\int_{-\infty}^{t} x(\tau)d\tau\right\} = X(jw)\left[\pi\delta(w) + \frac{1}{jw}\right]$	1 1 1 1		

	$$\int_{-\infty}^{t} x(\tau)d\tau \overset{FT}{\leftrightarrow} \frac{X(jw)}{jw} + \pi X(j0)\delta(w)$$	1		
(b)	The impulse response of a continuous time LTI system is given by $$h(t) = \frac{1}{RC} e^{\frac{-t}{RC}}\, u(t)$$ **Find** the frequency response and **draw** its spectrum.	5	Applying K3	CO4
Sol	$$H(jw) = \int_{-\infty}^{\infty} h(t)e^{-jwt}dt$$ $$H(jw) = \frac{1}{RC}\int_{-\infty}^{\infty} e^{-(jw+\frac{1}{RC})t}dt$$ $$H(jw) = \frac{\frac{1}{RC}}{jw + \frac{1}{RC}}$$ $$\lvert H(jw)\rvert = \frac{\frac{1}{RC}}{\sqrt{w^2 + \left(\frac{1}{RC}\right)^2}}$$ $$\measuredangle H(jw) = -tan^{-1}(wRC)$$ Spectrum	1 1 1 0.5 0.5 1		
(c)	**Obtain** the frequency response and impulse response of the system described by the difference equation $y[n] - \frac{1}{4}y[n-1] - \frac{1}{8}y[n-2] = 3x[n] - \frac{3}{4}x[n-1]$.	5	Applying K3	CO5
Sol	$$\frac{Y(e^{j\Omega})}{X(e^{j\Omega})} = \frac{3 - \frac{3}{4}e^{-j\Omega}}{1 - \frac{1}{4}e^{-j\Omega} - \frac{1}{8}e^{-j2\Omega}}$$ $$\frac{Y(e^{j\Omega})}{X(e^{j\Omega})} = H(e^{j\Omega}) = \frac{A}{e^{-j\Omega}+4} + \frac{B}{e^{-j\Omega}-2}$$ $$A = -1$$ $$B = \frac{1}{4}$$ Taking inverse DTFT, $$h[n] = \frac{1}{4}\left(\frac{1}{4}\right)^n u[n] - \frac{1}{8}\left(\frac{1}{2}\right)^n u[n]$$	2 1 2		
	OR			
4(a)	**Find** the time domain expression for the following $$X(jw) = \frac{2jw+1}{(2+jw)^2}$$	5	Applying K3	CO4
Sol	$$e^{-2t}u(t) \overset{FT}{\leftrightarrow} \frac{1}{(2+jw)}$$ $$te^{-2t}u(t) \overset{FT}{\leftrightarrow} \frac{1}{(2+jw)^2}$$	1 1		

	$$\frac{d}{dt}\{te^{-2t}u(t)\} \overset{FT}{\leftrightarrow} \frac{jw}{(2+jw)^2}$$ $$x(t) = \frac{d}{dt}\{te^{-2t}u(t)\}$$ $$x(t) = (1-2t)e^{-2t}u(t)$$	1 1 1		
(b)	Find the frequency response and the impulse response of the system described by differential equation $$\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = 4\frac{dx(t)}{dt} + x(t)$$	5	**Applying K3**	**CO4**
Sol	$$H(jw) = \frac{Y(jw)}{X(jw)} = \frac{4jw+1}{(jw+2)(jw+1)}$$ $$= \frac{A}{(jw+2)} + \frac{B}{(jw+1)}$$ $$A = 7$$ $$B = -3$$ $$= \frac{7}{(jw+2)} - \frac{3}{(jw+1)}$$ $$x(t) = 7e^{-2t}u(t) - 3e^{-t}u(t)$$	2 1 1 1		
(c)	State and prove frequency shift property of DTFT.	5	**Applying K3**	**CO5**
Sol	$$If\ x(n) \overset{DTFT}{\longleftrightarrow} X(e^{j\Omega})$$ $$then\ \ y(n) = e^{j\beta n}x(n) \overset{DTFT}{\longleftrightarrow} Y(e^{j\Omega}) = X(e^{j(\Omega-\beta)})$$ Proof: $$X(e^{j\Omega}) = \sum_{n=-\infty}^{\infty} x(n)\, e^{-j\Omega n}$$ $$Y(e^{j\Omega}) = \sum_{n=-\infty}^{\infty} e^{j\beta n}x(n)\, e^{-j\Omega n}$$ $$Y(e^{j\Omega}) = \sum_{n=-\infty}^{\infty} x(n)\, e^{-j(\Omega-\beta)n}$$ $$Y(e^{j\Omega}) = X(e^{j(\Omega-\beta)})$$	1 1 1 1 1		

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