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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fourth Semester B.Tech Degree Examination July 2021 (2019 Scheme)

Course Code: ECT204

Course Name: SIGNALS AND SYSTEMS

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

PART A

(Answer all questions; each question carries 3 marks) Marks

1	Determine energy of the signal $x(t) = e^{-2t}\, u(t)$	3
2	Plot the waveform of the following signal $x(t) = u(t + 1) - 2u(t) + u(t - 1)$	3
3	Perform linear convolution of signals $x_1[n] = [\ 2, 2, 2, 2\ ]$ and $x_2[n] = [\ 1, 1, 1, 1\ ]$	3
4	Find Laplace Transform and sketch ROC for the signal $x(t) = e^{2t}\, u(t) + e\text{-}^{3t}\, u(t)$	3
5	State sampling theorem of a band limited Continuous time signal.	3
6	Find the Nyquist rate and Nyquist interval of the following signal $x(t) = 3 \sin 100\pi\, t + 2 \cos 200\pi\, t$	3
7	Find DTFT of the signal $x[n] = \frac{1}{2}\left[\left(\frac{1}{2}\right)^n + \left(\frac{1}{4}\right)^n\right] u[n]$	3
8	State and prove differentiation property of DTFT	3
9	Derive the relation between DTFT and Z transform	3
10	Evaluate the transfer function H(z) of an LTI system described by $y[n] - \frac{1}{2}\ y[n-1] = 2x[n]$	3

PART B

(Answer one full question from each module, each question carries 14 marks)

Module -1

11	a)	Test whether the following signals are periodic or not. If periodic, determine the fundamental period and frequency. 1) $x(t) = 3\cos(5t + \pi/6)$ 2) $x(t) = e^{(j\pi - 2)\, t}$	6
	b)	Evaluate the discrete-time convolution sum with required plots for the following signal $y[n] = 3^n\, u[-n + 3] * u[n - 2]$	8

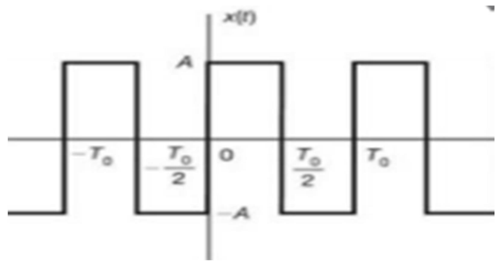
12 a) Evaluate the autocorrelation of the signal $x(t) = e^{-t}\,u(t)$ — 6

b) Evaluate the continuous time convolution integral for the following with proper plots. — 8

$y(t) = \{u(t) - u(t - 2)\} * u(t)$

Module -2

13 a) Find the trigonometric Fourier Series of the given continuous time square wave x(t). Plot the magnitude and phase spectra. — 7



b) Using the standard transforms and properties find Fourier Transforms of the following signals

i. $x(t) = t\,e^{-2t}\,u(t)$ — 7

ii. $x(t) = \sin(2\pi t)e^{-t}\,u(t)$

14 a) A periodic signal has the Fourier series representation — 9

$x(t) \xleftrightarrow{FS;\,\pi} X(k) = -k2^{-|k|}$

Without determining x(t), find the Fourier series Y(k) and ω_0' for

i. $y(t) = x(3t)$

ii. $y(t) = dx(t)/dt$

iii. $y(t) = x(t - 1)$

b) Find time domain signal represented by the Fourier Series coefficients — 5

$$X(k) = j\delta(k - 1) - j\delta(k + 1) + \delta(k - 3) + \delta(k + 3),\ \omega_0 = 2\pi$$

Module -3

15 a) A second order LTI system is described by the given differential equation. Use Laplace Transform to determine the transfer function the system — 8

$$\frac{d^2}{dt^2}y(t) + 4\frac{d}{dt}y(t) + 3y(t) = 4\,x(t) + 2\frac{d}{dt}x(t)$$

Also find the output y (t) of the system for a given input $x(t) = e^{-2t}\,u(t)$.

b) An arbitrary band-limited continuous time signal x(t) is sampled with an impulse train. With spectral details, explain the following conditions — 6

(i) Oversampling (ii) Critical Rate (iii) Aliasing

16 a) Determine a differential equation description for a system with the following transfer function 6

$$H(s) = \frac{2(s-2)}{(s+1)^2\ (s+3)}$$

b) Determine whether the system described by the following system is 8

i. Both causal and stable

ii. Whether a causal and stable inverse systems exist or not?

$$H(s) = \frac{(s+1)(s+2)}{(s+1)(s^2+2s+10)}$$

Module -4

17 a) i. Find convolution of the following two sequences using DTFT 8

$$x_1[n] = [\ 1, 2, 3, 1\ ]$$

$$x_2[n] = [\ 1, 2, 1, -1\ ]$$

ii. Find Inverse DTFT of

$$|H(\omega)| = 1 \qquad -\omega_0 \leq \omega \leq \omega_0$$

$$0 \qquad \text{otherwise}$$

b) Compute DTFS coefficients of the given discrete time signal. Plot its magnitude and frequency spectrum. 6

$$x[n] = \cos\left(\frac{6\pi}{13}n + \frac{\pi}{6}\right)$$

18 a) Use the defining equation for the DTFS to determine the time domain signal represented by the following DTFS coefficients by inspection 7

$$X[k] = 2j\sin(\frac{4\pi}{19}k) + \cos\left(\frac{10\pi}{19}k\right)$$

b) Given DTFT of $x[n] = n(3/4)^{|n|} \longleftrightarrow X(e^{j\Omega})$. 7

Using properties of DTFT, find y[n] for the following $Y(e^{j\Omega})$

i. $Y(e^{j\Omega}) = \frac{d}{d\Omega}X(ej\Omega)$

ii. $Y(e^{j\Omega}) = X(e^{j\Omega}) * X(e^{j(\Omega - \pi/2)})$

Module -5

19 a) Determine the Z Transform and ROC for the following signal. Sketch the ROC, poles and zeroes in the Z-plane. 8

$x[n] = (2/3)^{|n|}$

b) Write the impulse response of the system function whose algebraic expression is given below. Also check and justify the causality and Stability. 6

$$H(z) = \frac{1}{\left(1 - \frac{1}{2}z^{-1}\right)} + \frac{1}{(1 - 2z^{-1})}, \qquad \frac{1}{2} < |z| < 2$$

20 a) Evaluate the inverse Z-Transform by partial fraction method for the given X(z). 7

$$X(z) = \frac{3 - \frac{5}{6}z^{-1}}{\left(1 - \frac{1}{4}z^{-1}\right)\left(1 - \frac{1}{3}z^{-1}\right)}, \qquad |z| > \frac{1}{3}$$

b) Evaluate Z-Transform of the following. 7

i. $x[n] = [r^n cos\omega_0 n]\, u[n]$

ii. $x[n\ ] = n\left(\frac{1}{3}\right)^n u[n]$

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