

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

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|----|--|---|
| 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 $x(t) = e^{2t} u(t) + e^{-3t} u(t)$ | 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 |

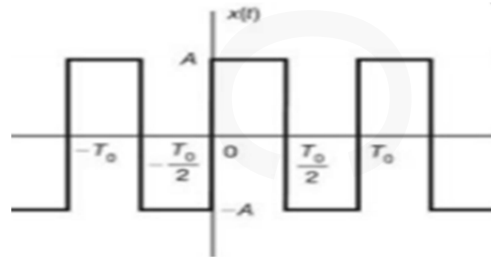
PART B*(Answer one full question from each module, each question carries 14 marks)***Module -1**

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|----|---|---|
| 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 7
 i. $x(t) = t e^{-2t} u(t)$
 ii. $x(t) = \sin(2\pi t) e^{-t} u(t)$
 14 a) A periodic signal has the Fourier series representation 9

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

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

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

$$0 \quad \text{otherwise}$$

- 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

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

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

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

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

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

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

- b) Evaluate Z-Transform of the following. 7

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

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