**ANSWER ALL THE QUESTIONS** **TOTAL MARKS: 30** **TIME:1.30 HR**

1.
(a) Determine the unit step response of the first order system governed by the equation [4] below with zero initial conditions.

$$\frac{dy(t)}{dt}+0.5y(t)=x(t)$$

(b) What is the importance of convolution? [1]

(c) State and prove the associative and commutative properties of convolution. [2]

(d) Find the state variable description of the circuit below, if the input is the applied voltage [3] x(t) and the output is the current y(t) through the resistor R_2.
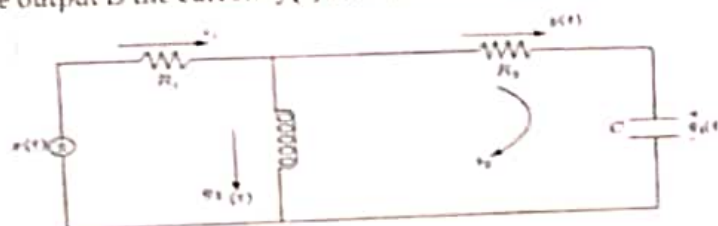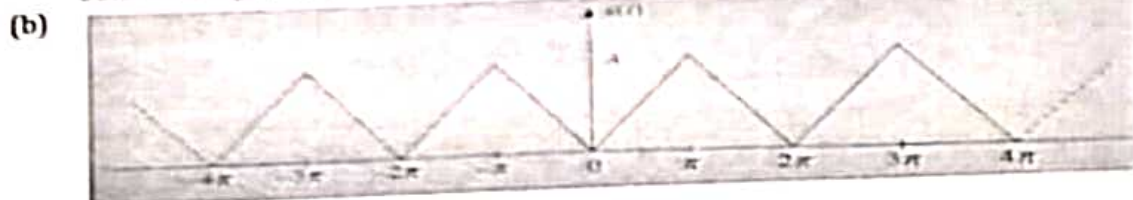

2.
(a) The state space representation of a discrete time system is given by, [5]

$A=\begin{matrix} 2 & -1 \\ 4 & 1 \end{matrix}$, $B=\frac{1}{2}$, $C=[1 \quad 3]$, $D=[3]$
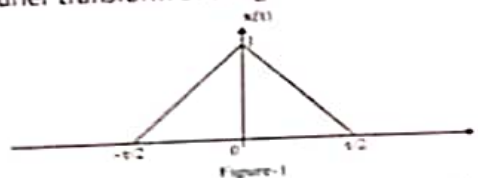
Derive the transfer function of the system.

(b) Obtain the trigonometric series for the waveform shown in figure [3]

(c) Explain about exponential Fourier series and derive the Fourier series coefficient [2]

3.
(a) State and proof Parseval's Theorem [2]

(b) Find the fourier transform of the given waveform [3]

Figure-1

(c) Determine whether the following signal is energy signal or power signal. Calculate its energy [2] or power?

X(t)=5cos4tcos6t

(d) Distinguish causal and anti-causal signals [1+2=3]
Sketch the following signal
2 u(t+2)- 2 u(t-3)

National Institute of Technology Mizoram
Class Test, Even Semester – 2022-23
Signals and Systems (EEL-1406)
4th Semester EEE & CSE   Full Marks: 15   Duration: 50 mins

Answer all Questions

1. Determine the Nyquist sampling rate and Nyquist sampling interval for the signal $x(t) = \text{sin} c^2 (200\pi t)$ (2)

2. Find the DTFT of $x[n]=3^n u[-n]$ (2)

3. If a discrete signal is represented by $x[n]= a^n u(n)$, then what is the value of the signal $g(n)= x(n) - ax(n-1)$? (2)

4. Consider the sequence $x[n]= (4-5j+j24)$ Find the conjugate anti-symmetric part of the sequence (3)

5. A 5-point sequence $x[n]$ is given as $x[-3]=1$, $x[-2]=1$, $x[-1]=0$, $x[0]=5$, $x[1]=1$. Let $X(e^{j\omega})$ denote the discrete-time Fourier transform of $X[n]$ Find the value of $\int_{-\pi}^{\pi} X(e^{j\omega})d\omega$ (3)

6. Given the finite length input $x[n]$ and the corresponding finite length output $y[n]$ of an LTI system as shown below. Find the impulse response $h[n]$ of the system. (3)

$$x[n]=\{1, -1\} \longrightarrow \boxed{h[n]} \longrightarrow y[n] = \{1, 0, 0, 0, -1\}$$

Answer all 5 (Five) Questions. All Questions Carry Same Marks

(5 x 10 = 50 Marks)

1. (a) Write the condition for LTI system to be stable and causal. [2]
   (b) If two LTI systems with impulse responses $h_1(t) = e^{-at} u(t)$ and $h_2(t) = e^{-bt} u(t)$ are connected in cascade, what will be the overall impulse response of cascaded system? [2]
   (c) What are the conditions for a system to be LTI System? [3]
   (d) What is Impulse Response? Show that the response of an LTI system is convolution integral of its impulse response with input signal? [3]

2. (a) Define Sampling theorem? Prove the sampling theorem and explain how the original signal can be reconstructed from the sampled version. [5]
   (b) Find the state transition matrix for the continuous time system parameter matrix, [5]
   $$A = \begin{matrix} -3 & 0 \\ 0 & -2 \end{matrix}$$

3. (a) Determine whether the following systems are: i) Memory less, ii) Stable iii) Causal iv) Linear and v) Time-invariant. [4]
   i) $y(n) = nx(n)$
   ii) $y(t) = e^{x(t)}$

   (b) Find the trigonometric fourier series representation of a periodic square wave [3]
   $$x(t) = 1, for\ the\ interval\ (0,\pi)$$
   $$= 0, for\ the\ interval\ (\pi, 2\pi)$$

   (c) Find the Z transform of the given system [3]
   $$x[n] = (3)^n\ U[n] + (4)^n\ U[-n - 1]$$

4. (a) Give the Existence of DTFT [2]

   (b) Find the Nyquist sampling rate from the analog signal [2]
   $$m(t) = 4\cos(100\pi t) + 8\sin(200\pi t) + \cos(300\pi t)$$

   (c) State whether the given signal is energy or power signal [3]
   $$X[n] = \left(\frac{1}{2}\right)^n u(n)$$

   (d) Determine the value of the given signal [3]
   $$I = \int_{-\infty}^{+\infty} [\cos(\pi t).\delta(t-2) + 3\delta(t+1) + \sin(\pi t).\delta(2t-1)]dt$$

5. (a) For the given system determine even, odd conjugate symmetric and conjugate anti symmetric components. [2]
   $$X[n] = \{-4 - 5j, \underline{1 + 2j}, 4\}$$

   (b) Find DTFT of the given signal [3]
   $$X[n] = -a^n u[-n - 1]$$

   (c) Calculate Nyquist rate in rad/sec and frequency in Hz for the given signal [2]
   $$m(t) = 2\sin(4\pi t) + \cos(2\pi t)$$

   (d) Let m(t)= 10sin(400πt) to be sampled at 300 Hz and reconstructed using an ideal Low Pass Filter with cut off frequency of 150 Hz. Find the frequencies present in the reconstructed signal. [3]

Answer all the questions

1. Find the given signal is energy or power signal.   [4]

    a) $x(n) = (1/4)^n u(n)$
    b) $x(t) = 0.9e^{-3t} u(t)$

2. Determine whether the given systems are: i) memory less, ii) time-invariant, iii) linear, iv) causal or v) BIBO stable. Justify your answers.   [7]

    a) $y[n] = x[1-n]$
    b) $y(t) = x(t)/(1+x(t-1))$

3. Define different types of signals with examples.   [4]