B. Sc. in EEE, 6th Semester 07 March 2024 (Morning)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination **Summer Semester: A. Y.2022 - 23**
Course Number: EEE 4601 **Time: 90 Minutes**
Course Title: Signals and Systems **Full Marks: 75**

There are **03 (Three)** questions. Answer **all** questions. Question 2 has an alternative. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Define a Linear Time Variant (LTI) system. Mention the benefits of approximating a system as an LTI in finding the output of the system for an arbitrary input signal bounded in time. **(5) (CO1) (PO1)**

   b) A signal $x(t)$ is defined by **(10) (CO1) (PO1)**

$$x(t) = \begin{cases} 5-t, & 4 \le t \le 5 \\ 1, & -4 \le t \le 4 \\ t+5, & -5 \le t \le -4 \\ 0, & otherwise \end{cases}$$

   Determine the total energy of $x(t)$. If the signal is time scaled to form $y(t) = x(10t)$, what is the energy of y(t)?

   c) A complex exponential DT signal $x[n] = e^{j\Omega_0 n}$ is obtained by sampling its continuous version. Derive the condition when $x[n]$ will be periodic with a fundamental period of N_0 samples. A signal $x(t) = \sin(150t)$ is uniformly sampled with a sampling interval of $T_s = 0.01\pi$ seconds. Determine the fundamental period of $x[n]$. **(10) (CO1) (PO1)**

2. a) Show that $x(t) * \delta(t) = x(t)$, where '*' stands for convolution operation. A CTLTI system has the impulse response $h(t)$ depicted in Fig. 2(a). Use linearity and time invariance to determine the system output $y(t)$ if the input $x(t)$ is $x(t) = \delta(t) + \delta(t+T) + \delta(t-T) + \delta(t+2T) + \delta(t-2T)$ for $T = 1$, $T = 2$ and $T = 4$. **(10) (CO1) (PO1)**

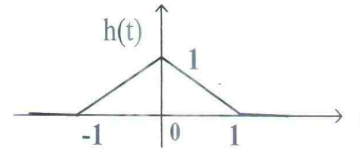

Fig. 2(a)

b) A DTLTI system has the impulse response $h[n] = \left(\frac{1}{2}\right)^n u[n-2]$. Determine and draw stem diagram for the output of the system if the input $x[n] = u[n]$. **(10) (CO1) (PO1)**

c) Relate the LTI system properties of (i) the Memoryless System, (ii) the Causal System, and (iii) the invertible system and the impulse response of the systems. **(5) (CO1) (PO1)**

OR -Question 2

a) Determine the output of a CTLTI system having an impulse response $h(t) = u(t)$ for the input $x(t) = \cos(\pi t)\,[u(t+1) - u(t-1)]$ using convolution. **(10) (CO1) (PO1**

b) A DTLTI system has the impulse response $h[n] = \left(\frac{1}{4}\right)^n u[n]$. Determine and draw stem diagram for the output of the system if the input $x[n] = u[n+2]$. **(10) (CO1) (PO1)**

c) Derive the relationship between the impulse response $h[n]$ and step response $s[n]$ of a DTLTI system. Evaluate the step response of the system with $h[n]$ given in (b) above. **(5) (CO1) (PO1**

3. a) Derive a differential equation relating the output $y(t)$ with input $x(t)$ for an initially relaxed system shown in Fig. 3(a) and hence, find the output $y(t)$ for $x(t) = 5e^{-3t}u(t)$ V. Assume $R_1 = R_2 = 10\ k\Omega$, $C_1 = 10\ \mu F$, and $C_2 = 100\ \mu F$. **(13) (CO2) (PO2)**

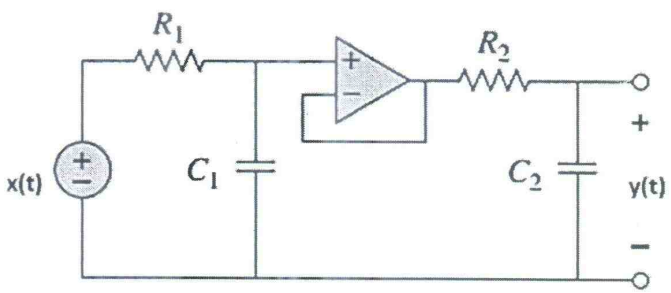

Fig.3(a)

b) Identify the natural and forced responses of the DTLTI system described by the following difference equation with initial conditions and input specified. **(12) (CO2) (PO2)**

$$y[n] - \frac{1}{9}y[n-2] = x[n-1]$$

$$y[-1] = 1, y[-2] = 0, and\ x[n] = 2u[n].$$