B. Sc. in EEE, 6th Semester **20 May 2024 (Morning)**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Semester Final Examination | **Summer Semester: A. Y.2022 - 23**
Course Number: EEE 4601 | **Time: 3.0 Hours**
Course Title: Signals and Systems | **Full Marks: 150**

There are **06 Six)** questions. Answer **all** questions. Questions 2 and 4 have alternatives. 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.

1. a) Describe the procedure of evaluating convolution sum by reflect and shift method. Show that the step response of a DTLTI system with $h[n] = \left(\frac{3}{4}\right)^n u[n]$ approaches to 4.0 at the steady state. **(12) (CO1) (PO1)**

   b) The impulse response of a CTLTI is given as $h(t) = \delta(t) - e^{-t}u(t)$. Determine and sketch the output of the system if the input $x(t) = u(t) - u(t-2)$. **(13) (CO1) (PO1)**

2. a) The simplified circuit of a 240 W power supply that employs a large inductor and a large capacitor is shown in Fig. 2(a). Find $i_L(t)$ for $t > 0$. The circuit was at steady state before the switch opens at $t = 0$. **(13) (CO2) (PO2)**

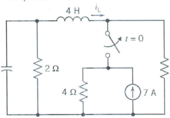


Fig. 2(a)

   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)**

$$y[n] - \frac{3}{4}y[n-1] + \frac{1}{8}y[n-2] = 2x[n]$$
$$y[-1] = 1, y[-2] = -1 \text{ and } x[n] = 2u[n].$$

Question 2 OR

a) The input $x(t)$ and the impulse response $h(t)$ of an LTI system are shown in Fig. 2(a)-OR. Find the zero-state response(ZSR) of the system. **(13) (CO2) (PO2)**

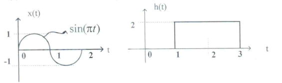


Fig. 2(a)-OR

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)**

$$y[n] - \frac{1}{4}y[n-1] - \frac{1}{8}y[n-2] = x[n] + \frac{11}{8}x[n-1]$$

$$y[-1] = -1, y[-2] = 26 \text{ and } x[n] = (2)^n u[n].$$

3. a) One cycle of a periodic input voltage to the circuit in Fig. 3(a) is shown below. Find the output of the circuit for $k = 0$ and $k = \pm 1$, harmonics. **(13) (CO2) (PO2)**

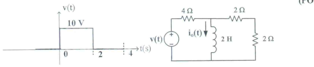


Fig. 3(a)

b) One cycle of a DT periodic signal is defined as, **(12) (CO2) (PO2)**

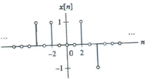
$$x[n] = \begin{cases} 1, & n = 0 \\ 2, & n = 1 \\ 0, & n = 2, 3, 4 \\ 2, & n = 5 \end{cases}$$

Determine the Fourier Series coefficient $X[k]$ of the signal and show that $X[k]$ is periodic in k with a period equal to the period of $x[n]$.

4. a) Determine the Fourier Transform(FT) to represent the following aperiodic DT signals in the frequency domain. **(10)** **(CO2)** **(PO2)**

(i) $x[n] = \begin{cases} \frac{1}{2} + \frac{1}{2}\cos\left(\frac{\pi}{N}n\right), & |n| \leq N = 10 \\ 0, & otherwise \end{cases}$

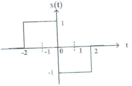
(ii)



b) Determine the Fourier Transform(FT) to represent the following aperiodic CT signals in the frequency domain. **(10)** **(CO2)** **(PO2)**

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

(ii)



c) Evaluate the sum using Parseval's theorem. **(5)** **(CO2)** **(PO2)**

$$X = \sum_{k=0}^{29} \frac{\sin^2(11\pi k/30)}{\sin^2(\pi k/30)}$$

Question 4 OR

a) Determine the time domain signal $x(t)$ represented by the Fourier coefficients as depicted in Fig.4(a)-OR The fundamental angular frequency of the signal is $\omega_0 = 2\pi$ rad/s. **(10) (CO2) (PO2)**

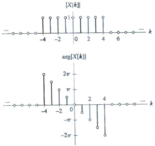


Fig. 4(a)-OR

b) The frequency domain representation of a CT signal $x(t)$ is $X(j\omega) = \frac{20}{4+j\omega}$. The signal is passed through a low pass filter with cutoff frequency 2 rad/s. Determine the fraction of energy in the input of the signal is contained in the stop band. **(10) (CO2) (PO2)**

c) An exponential signal $x(t) = 3e^{-t}u(t)$ is applied to a CTLTI system with $h(t) = 2e^{-2t}u(t)$. Determine its output $y(t)$ by using the convolution property of FT **(5) (CO2) (PO2)**

5. a) Find and draw the spectrum of the sampled version of the CT signal having the FT shown below in Fig. 5(a) for (i) $T_s = \frac{1}{2}$ s and (ii) $T_s = 2$ s. **(10) (CO3) (PO2)**

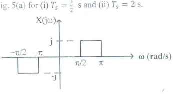


Fig. 5(a)

b) An isolated sawtooth pulse is shown in the Fig. 5(b) below. Find the Laplace Transform (LT) of the pulse (i) after decomposing it using ramp and unit step functions, and (ii) by using differentiation and integration properties of LT. **(10)** **(CO3)** **(PO2)**

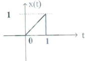


Fig. 5(b)

c) Find the frequency and impulse responses of the system described by the difference equation. $6y[n] + 5y[n-1] + y[n-2] = 18x[n] + 8x[n-1]$. **(5)** **(CO3)** **(PO2)**

6. a) "One of the advantages of LT in LTI system analysis is the natural response and forced response of the system can be determined simultaneously." – Justify the statement. **(13)** **(CO3)** **(PO2)**

Determine the forced and natural responses of the LTI system described by $\frac{d^2y(t)}{dt^2} + 4y(t) = 8x(t)$, with input $x(t) = u(t)$ and initial conditions $y(0^-) = 1$ and $\frac{dy(t)}{dt}|_{t=0^-} = 2$.

b) Draw the S-domain form of the circuit shown in Fig. 6(b) for $t > 0$, and hence determine $i(t)$. **(12)** **(CO3)** **(PO2)**

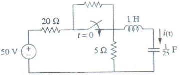


Fig. 6(b)