

(Time: $2\frac{1}{2}$ hours)

[Marks: 75]

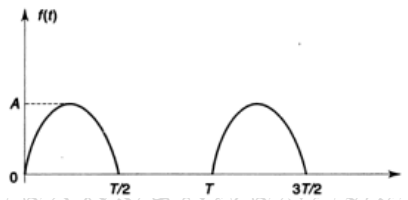
Please check whether you have got the right question paper.

- N. B.: (1) **All** questions are **compulsory**.
 (2) Make **suitable assumptions** wherever necessary and **state the assumptions** made.
 (3) Answers to the **same question** must be **written together**.
 (4) Numbers to the **right** indicate **marks**.
 (5) Draw **neat labeled diagrams** wherever **necessary**.
 (6) Use of **Non-programmable** calculator is **allowed**.

1. Attempt **any two** of the following:

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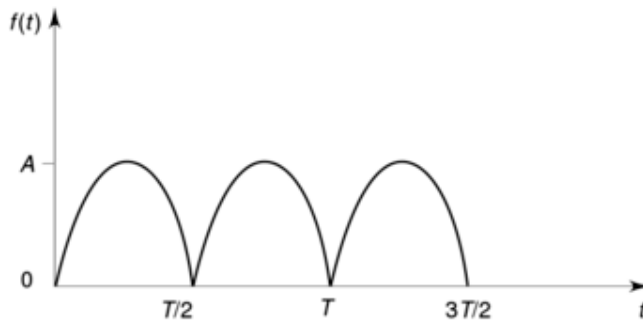
- State and explain the properties of unit impulse function $\delta(t)$.
- How are continuous and discrete time systems classified? Explain.
- What are energy and power signals? Determine if the following signals are energy signals or power signals or neither:
 - $x(t) = tu(t)$
 - $x(n) = (-0.5)^n u(n)$
- Obtain the trigonometric Fourier series for the half wave rectified sine wave shown below:



2. Attempt **any two** of the following:

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- Find the Laplace transform of the following functions
 - $f(t) = \frac{1-e^{-t}}{t}$
 - $f(t) = \cos^3 3t$
- Find the Laplace transform of the full wave rectified output as shown below:



[TURN OVER]

- c. Find the inverse Laplace transform of $\left\{ \frac{s^2 - s - 3}{(s+5)(s+4)^2} \right\}$
- d. The unit step of a network is $(1 - e^{-at})$. Determine the impulse response $h(t)$ of the network.

3. Attempt any two of the following:

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- a. A system has an impulse response $h(n) = \{1,2,3\}$ and output response $y(n) = \{1,1,2, -1,3\}$. Determine the input sequence $x(n)$.
- b. Determine the z-transform for the analog input signal $x(t) = e^{-at}$ applied to a digital filter.
- c. How is z-transform obtained from Laplace transform? Derive the z-transform of $f(nT) = \cos \omega nT$
- d. Define one-sided z-Transform, Two-sided z-Transform and Inverse z-Transform.

4. Attempt any two of the following:

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- a. Explain the Paley – Wiener criteria.
- b. Consider a causal and stable LTI system whose input $x(n)$ and output $y(n)$ are related through the second order difference equation

$$y(n) - \frac{1}{12}y(n-1) - \frac{1}{12}y(n-2) = x(n)$$

- Determine the step response for the system.
- c. Find the response of the following difference equation $y(n) - 5y(n-1) + 6y(n-2) = x(n)$ for $x(n) = u(n)$
- d. A second order discrete time system is characterised by the difference equation $y(n) - 0.1y(n-1) - 0.02y(n-2) = 2x(n) - x(n-1)$
Determine $y(n)$ for $n \geq 0$ when $x(n) = u(n)$ and the initial conditions are $y(-1) = -10$ and $y(-2) = 5$

5. Attempt any two of the following:

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- a. Find the 4-point DFT of the sequence $x(n) = \cos \frac{n\pi}{4}$.
- b. Compute the circular periodic convolution graphically of the two sequences:
 $x(n) = \delta(n) + \delta(n-1) - \delta(n-2) - \delta(n-3)$ and
 $h(n) = \delta(n) - \delta(n-2) + \delta(n-4)$
- c. Determine the cross-correlation values of the two sequences $x(n) = \{1,0,0,1\}$ and $h(n) = \{4,3,2,1\}$.
- d. Distinguish between linear convolution and circular convolution.

[TURN OVER]

6. Attempt **any two** of the following:

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- a. Design a digital Chebyshev filter to satisfy the constrains

$$0.707 \leq |H(e^{j\omega})| \leq 1, \quad 0 \leq \omega \leq 0.2\pi$$

$$|H(e^{j\omega})| \leq 0.1, \quad 0.5\pi \leq \omega \leq \pi$$

Using bilinear transformation and assuming $T = 1s$.

- b. Design a Finite Impulse Response low pass filter with a cut-off frequency of 1kHz and sampling rate of 4kHz with eleven samples using Fourier series.
- c. An analog filter has the following system function. Convert this filter into a digital filter using backward difference for the derivative.

$$H(s) = \frac{1}{(s+0.1)^2 + 9}$$

- d. Write a short note on Butterworth filters.

7. Attempt **any three** of the following:

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- a. Write a short note on Dirichlet's conditions.
- b. In the parallel RLC circuit. $I_0 = 5 A$, $L = 0.2 H$, $C = 2 F$ and $R = 0.5 \Omega$. Switch S is opened at time $t=0$. Obtain the complete particular solution for the voltage $v(t)$ across the parallel network. Assume zero current through inductor L and zero voltage across capacitor C before switching.

- c. Convolve the sequences $x(n)$ and $h(n)$ where

$$x(n) = 0, n < 0$$

$$= a^n, n \geq 0$$

$$h(n) = 0, n < 0$$

$$= b^n, n \geq 0$$

Specify the answers if (i) $a = b$ and (ii) $a \neq b$

- d. Find the convolution of the two signals
 $x(n) = u(n)$ and $h(n) = a^n u(n)$, ROC: $|a| < 1; n \geq 0$
- e. Find the circular periodic convolution using DFT and IDFT of the two sequences:
 $x(n) = \{ 1, 1, 2, 2 \}$ and $h(n) = \{ 1, 2, 3, 4 \}$
- f. Design an analog BPF to satisfy the following specifications:
 (i) 3 dB upper and lower cut-off frequencies are 100 Hz and 3.8 kHz
 (ii) stop band attenuation of 20 dB at 20 Hz and 8 kHz.
 (iii) No ripple with both passband and stopband.