(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: **10**

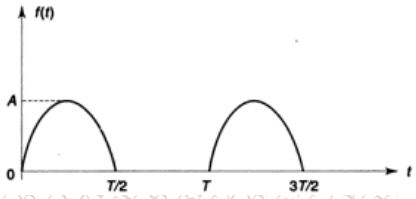
a. State and explain the properties of unit impulse function $\delta(t)$.

b. How are continuous and discrete time systems classified? Explain.

c. What are energy and power signals? Determine if the following signals are energy signals or power signals or neither:

i. $x(t) = tu(t)$ ii. $x(n) = (-0.5)^n u(n)$

d. Obtain the trigonometric Fourier series for the half wave rectified sine wave shown below:



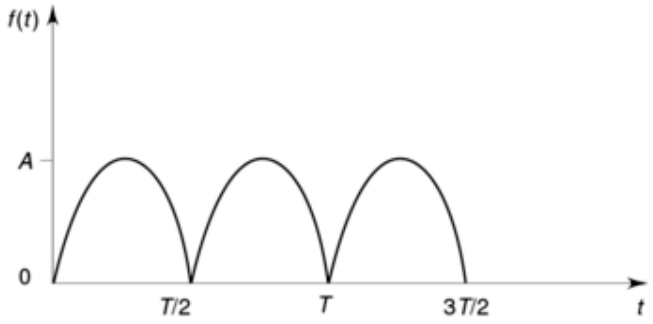
2. Attempt *any two* of the following: **10**

a. Find the Laplace transform of the following functions

(i) $f(t) = \frac{1-e^t}{t}$

(ii) $f(t) = cos^3 3t$

b. Find the Laplace transform of the full wave rectified output as shown below:



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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: **10**

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: **10**

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 imitial conditions are
y(–1) = –10 and *y*(–2) = 5

5. Attempt *any two* of the following: **10**

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.

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6. Attempt *any two* of the following: **10**

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: **15**

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 Ω. 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 ≥ 0
h(n) = 0, n < 0
= b^n, n ≥ 0
Specify the answers if (i) *a* = *b* and (ii) *a* ≠ *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.
