Total number of printed pages: 2 **UG /3rd Semester/UECE303**

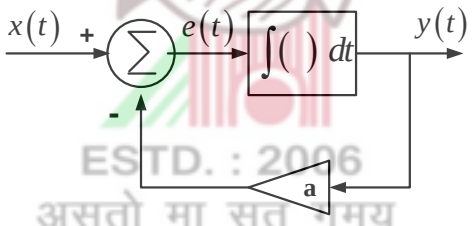
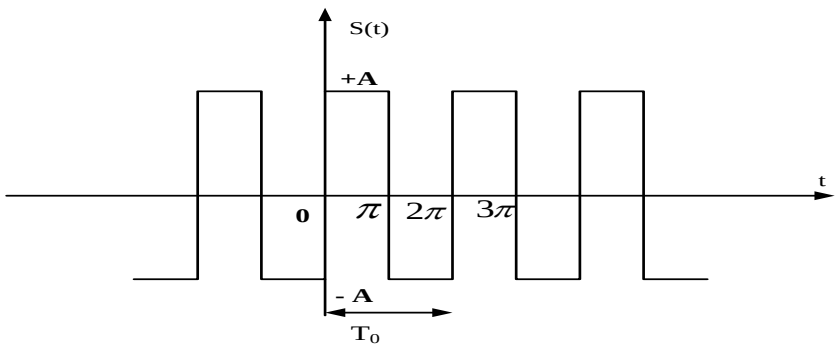
2024
SIGNALS AND SYSTEMS

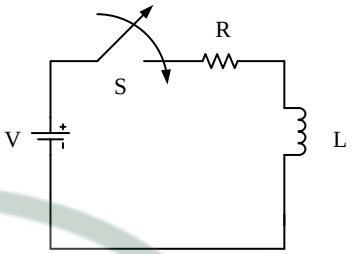
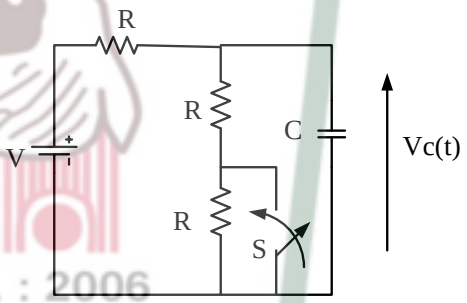
Full Marks: 100

Time: Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1.	a)	Show that (i) $x_e(t)=\frac{[x(t)+x(-t)]}{2}$ and (ii) $x_o(t)=\frac{[x(t)-x(-t)]}{2}$; where '$x_e(t)$' and '$x_o(t)$' are the even and the odd components of the signal '$x(t)$'.	5+5 = **10**
	b)	If the input applied to an LTI system with impulse response '$h(t)$' is '$x(t)$', deduce the output '$y(t)$' from the LTI system.	**10**
2.	a)	Show that the complex exponential '$e^{j\omega_0 t}$' is periodic with time period '$T_0 = k\times\left(\frac{2\pi}{\omega_0}\right)$'.	**5**
	b)	Prove that the power of the energy signal is zero and the energy of the power signal is infinite.	**5**
	c)	 The above system consists of one continuous time integrator, a scalar multiplier 'a' and a summer. Write a differential equation that relates the instantaneous output '$y(t)$' with the input '$x(t)$'.	**10**
3.	a)	In the given figure, find the continuous-time Fourier series (CTFS) representation of '$S(t)$':  Hence, show that only the odd harmonics of the series exist.	8+2 = **10**

	b)	Find the Fourier transform of a rectangular pulse $\Pi\left(\frac{t}{\tau}\right)$; where 'τ' is the pulse width of the pulse. Hence find the zero crossings of the spectrum of the rectangular pulse.	6+4 = **10**
4.	a)	In the RL circuit shown below, a unit step input voltage '$V \times u(t)$' is applied with all initial conditions assumed to be zero.  Using Laplace transform, find the current through the circuit. Find the voltage across the resistance and the inductance. Hence plot the voltage across the resistance and the inductance.	5+2+3 = **10**
	b)	The circuit given below is initially in the steady state with the switch 'S' open. The switch is closed at $t = 0$. i) Find $V_C(t)$. ii) Determine the final value of '$V_C(t)$' and verify it from the final value of Laplace transform.  	7+3 = **10**
5.	a)	What are band-limited signals? State the sampling theorem for a low-pass band-limited signal. Hence show that the spectrum of sampled waveform, in case of impulse sampling, is the repetition of the spectrum of low-pass band-limited signal.	1+2+10 = **13**
	b)	Show that the transfer function of a Zero-Order Hold (ZOH) circuit is given by $\frac{\tilde{X}_a(s)}{X(s)} = \frac{1-e^{-sT_s}}{s}$; where the symbols have their usual meaning.	**7**
6.	Write short notes on ***any two*** from the following:		10+10 = **20**
	a)	BIBO stability of LTI system.	
	b)	DC component of a signal using the polar form representation of the Fourier series.	
	c)	Fourier transform of unit step function $(u(t))$.	
	d)	Reconstruction with a low-pass filter: Sinc interpolation.	

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