2023

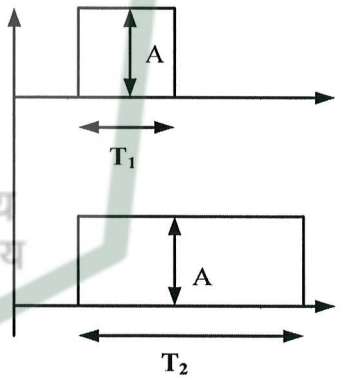
SIGNALS AND SYSTEMS

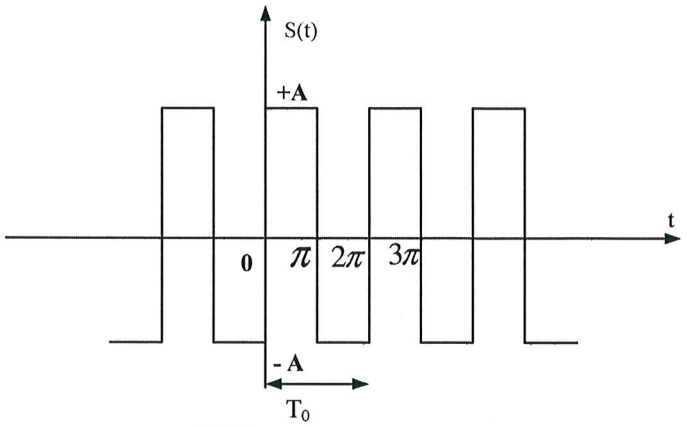
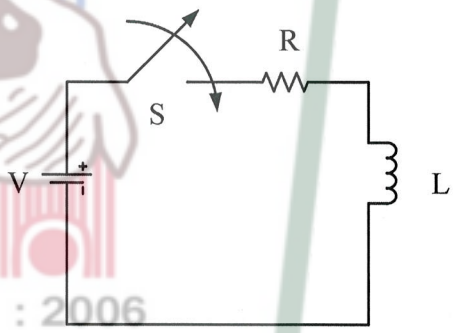
Full Marks: 100

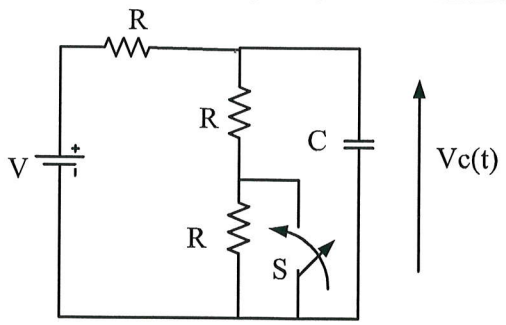
Time: Three hours

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)	Find whether the given signal is periodic or aperiodic. If it is periodic, calculate the fundamental frequency: $x(t)=\sin(10t+1)-2\cos(5t-2)$	4+6
2.	a)	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.	5
	b)	Find the result of the convolution of two identical pulse of amplitude 'A'. What will be the result of two non-identical pulses shown in the figure? 	2+3 = 5
	c)	Prove that the power of the energy signal is zero. Prove that the energy of the power signal is infinite.	5+5 = 10
3.	a)	In the given figure, find the continuous-time Fourier series (CTFS) representation of '$S(t)$':	8+2 = 10

		 Hence, show that only the odd harmonics of the series exist.	
	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 '$V = u(t)$' 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)	Find the impulse response '$h(t)$' of an ideal reconstruction filter. Hence find the output from a zero-order hold (ZoH) circuit.	5+10 = 15
	b)	Calculate the Nyquist rate (f_s) and the Nyquist interval (T_s) for the given signal: $x(t)=1+\cos(2000\times\pi\times t)+\sin(4000\times\pi\times t)$.	5
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)	Ideal impulse sampling and Nyquist theorem	
	d)	Z-transform and RoC of $-a^n\times u(-n-1)$.	

XXXXXXXX