Ref No: Ex/EE/T/224/2017

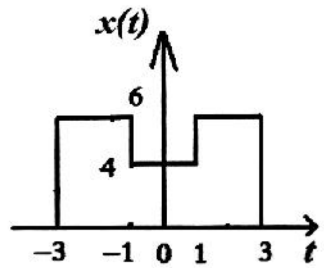
BACHELOR OF ENGINEERING IN ELECTRICAL ENGINEERING
EXAMINATION, 2017
(2ND Year, 2nd Semester)

SIGNALS AND SYSTEMS

Full Marks 100

Time: Three hours **(50 marks for each part)**

Use a separate Answer-Script for each part

No. of Questions	PART I	Marks
	Answer any THREE questions **Two marks reserved for neat and well organized answers.**	
1 (a)	**Determine the expression for the Fourier transform, the energy spectral density and the autocorrelation function of the signal *x(t)* shown in Fig. [A].** ***Knowledge of Fourier transforms of standard functions may be used.***	10
	 **Fig. [A]**	
(b)	**Using appropriate properties of Fourier transform, Obtain the inverse transforms of,** $(i) X_1(jf) = e^{-2\lvert f \rvert}$ $(ii) X_2(jf) = e^{-\lvert f \rvert} - jf\,\mathrm{sgn}(f)$	2+4
2.(a)	**Evaluate the following integrals.** $(i)\ \int_{0}^{4} e^{(t-1)}.\,\delta(t-3)\,dt$ $(ii)\ \int_{-\infty}^{1/2} \mathrm{Sin}(2\pi t)\left[\delta\left(t-\frac{1}{4}\right)+\delta\left(t-\frac{3}{4}\right)\right]dt$ $(ii)\ \int_{-\infty}^{+\infty} e^{(\tau-1)}.\,Cos\left[\frac{\pi}{2}(\tau-5)\right].\delta(\tau-t+3)\,d\tau$	6

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<table>
<tr><th>No. of Questions</th><th>PART I</th><th>Marks</th></tr>
<tr><td>(b)</td><td>

Sketch the derivative of the signal *f(t)* shown in Fig. [B], *and* express *f(t)* in terms of singularity functions.

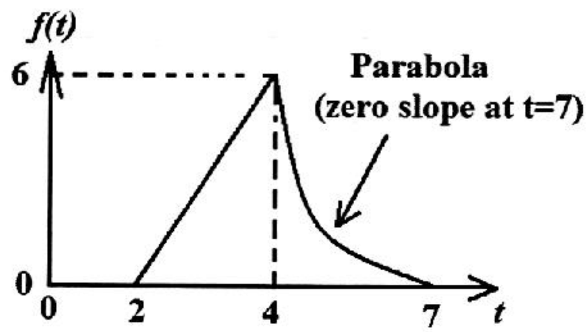

Fig. [B]

If the response of a linear time-invariant (LTI) system to a unit ramp input is $\Phi(t) = tu(t) - \left(1 - \frac{1}{3}e^{-3t}\right)u(t)$ **, obtain the expression for the response of the system when excited by the signal *f(t)*.**

</td><td>10</td></tr>
<tr><td>3 (a)</td><td>

Determine the exponential Fourier series for the signal z(t) depicted in Fig. [C]. Sketch the one-sided amplitude, phase and power density spectra up to 5th harmonic. Also obtain the expression for the Fourier cosine series of z(t).

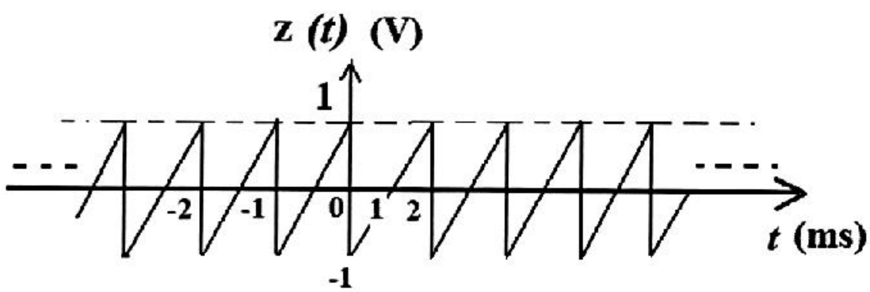

Fig. [C]

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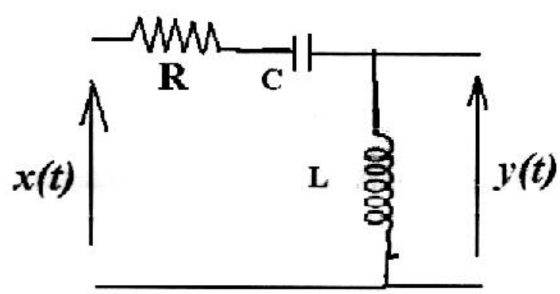
No. of Questions	PART I	Marks
(b)	Sketch the signal $h(t) = u(\text{Cos}(\pi t) + 0.5)$. Determine the duty cycle and crest factor of *h(t)*. Also check the periodicity of the integral of *h(t)*.	6
4.	In the circuit shown in Fig. [D], *x(t)* is the input voltage and the voltage *y(t)* across the inductor is the output. If R = 100 mΩ, L = 10 mH and C = $\frac{1}{90}$ mF, derive the expression for the amplitude response function and the phase response function of the system. Obtain the expression for the output *y*(t) of the circuit under steady state condition, when the input *x*(t) is the periodic signal *z*(t) given in Fig. [C].  Fig [D]	16
5.	Write short notes on any *two* of the following.	8+8
(a)	Energy signals and power signals.	
(b)	Properties of convolution of signals (no proofs required).	
(c)	Determination of Fourier transforms of unit dc, signum function and unit step.	

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B. ELECTRICAL ENGINEERING 2^ND^ YEAR 2^ND^ SEMESTER EXAMINATION, 2017

Subject: SIGNALS & SYSTEMS **Time: Three Hours** **Full Marks: 100**

Part II (50 marks)

Question 1 is compulsory

Answer ***Any Two*** questions from the rest (2×20)

Question No.			Marks
Q1		Answer ***any Two*** of the following:	
	(a)	Determine if the system $\dot{y}(t) + 4ty(t) = 2x(t)$ is time-invariant, linear, causal, and/or memoryless?	5
	(b)	Find state equations for the following system $\ddot{y}(t) - 4y(t) = u(t)$.	5
	(c)	Find the unit impulse response of the system characterized by the following differential equation $\dot{y} + ay = x$. Assume zero initial condition.	5
	(d)	Find an analog simulation for the equation $y = 3x$, given $\|x\|_{max} = 20$, and $\|y\|_{max} = 20$. Consider full amplifier range of 0 to 10 volts.	5
Q2	(a)	Given the following system: $$G(s) = \frac{10}{s^2 + 10s + 100}$$ (i) Plot the pole locations and find the corresponding values of ζ and ω_n. (ii) Plot the unit step response indicating rise time, peak-time, peak overshoot, settling time and steady-state value.	4+12
	(b)	Find the value of $x(t)$ as $t \to \infty$ (if it exists) for $$X(s) = \mathfrak{L}[x(t)] = \frac{10(s+1)}{s^2 + 4s + 8}$$	4
Q3	(a)	Given the electrical network of Figure P-3(a), find a state-space representation considering the current through the resistor as the output.	12

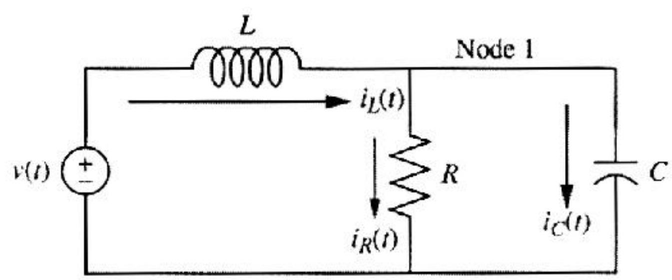

Figure P-3(a)

	(b)	Solve the following differential equations using the Laplace Transform method $\ddot{y} + 4\dot{y} + 20y = 2\dot{x} - x,\quad x(t) = u(t),\qquad x(0) = 0, y(0) = 0, \dot{y}(0) = 1.$	8

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Q4 (a) Draw an asymptotic Bode magnitude plot with approximate phase plot for the system having a transfer function: 8+4

$$G(s) = \frac{(s+3)}{(s+2)(s^2+2s+25)}$$

(b) (i) Write the differential equation governing the dynamic behaviour of the mechanical system, as shown in Figure P-4(b).

(ii) Obtain the analogous electrical network based on *force-voltage* analogy. 4+4

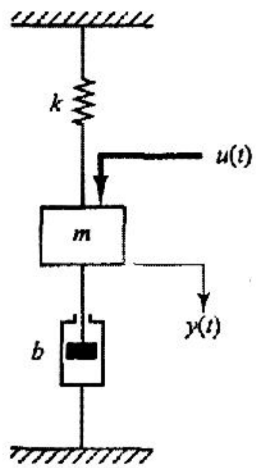

Figure P-4(b)

Q5 (a) (i) Draw analog simulation diagram for the following system, and, (ii) obtain magnitude-scaled analog simulation of the system to utilize the full amplifier range of 0 to 10 volts without any overloading. 4+8

$$\ddot{x} + 2\dot{x} + 25x = 0, \quad x(0) = 20, \quad \dot{x}(0) = 0,$$

with, $|x|_{max} = 20$, $|\dot{x}|_{max} = 100$.

(b) Obtain the transfer function, $E_o(s)/E_i(s)$, for the Op-amp circuit shown in Fig P-5(b). Consider the Op-amp to be an ideal one. 8

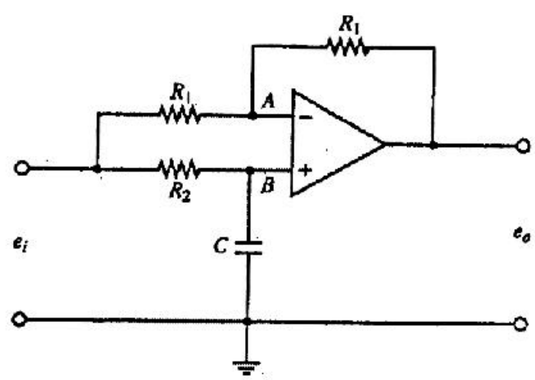

Figure P-5(b)