Ref No: Ex/EE/T/224/2018

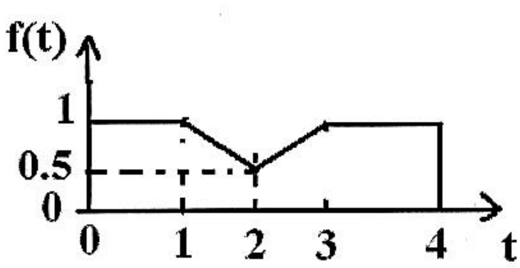
B.E. IN ELECTRICAL ENGINEERING SECOND YEAR SECOND SEMESTER 2018

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 expressions for the Fourier transforms of the following.** (i) $x(t) = e^{j\omega_o t} u(t-\tau)$ (ii) $f(t) = e^{-3t} Cos(10\pi t) u(t)$	3+4
(b)	**A function represented by h(t) can take on only real non-negative values for all t and the area under the function is unity. If $H(jf)$ represents the Fourier transform of $h(t)$, show that the $H(jf)$ can never be purely imaginary, and** $\int_{-\infty}^{+\infty} \lvert H(jf) \rvert df \le 1$.	5
(c)	**Evaluate the integral** $$\int_{-\infty}^{+\infty} \frac{Sin^2(\pi t)}{\pi^2 t^2} dt$$	4
2.(a)	**Express $f(t)$ shown in Fig. [A], in terms of singularity functions and also sketch its derivative.**  **Fig. [A]**	

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No. of Questions	PART I	Marks
	If the impulse response of a linear time-invariant (LTI) system is $h(t)=2e^{-t/5}u(t)$, obtain the expression for the response of the system when excited by the signal *f(t)*. *Do not use any transform method.*	**6+4**
(b)	**What are *total energy* and *average power* of signals. Point out the classification of signals into *'Energy Signals'* and *'Power Signals'*. Cite appropriate examples.**	**6**
3 (a)	**Investigate the significance of AC-coupled crest factor of periodic trains of rectangular pulses.**	
	Establish the relation(s) between the duty cycle and the AC-coupled crest factor of such signals.	**3+5**
(b)	**Define odd and even function symmetries of signals.**	
	Decompose the signal shown in Fig. [B] into odd and even components.	**2+6**

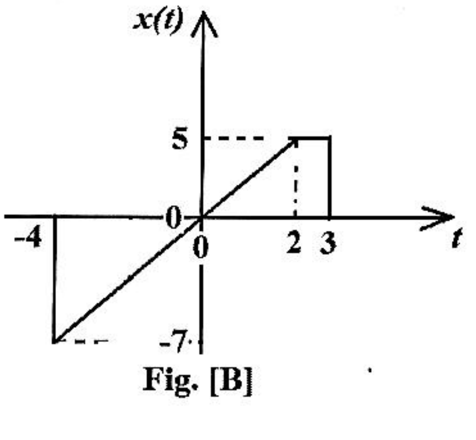

Fig. [B]

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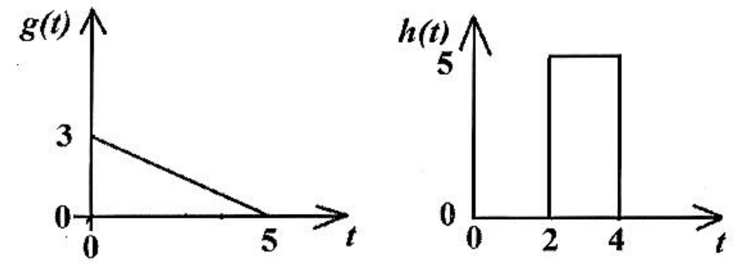
No. of Questions	PART I	Marks
4 . (a)	Introduce the concept of *'Power Spectral Density'(PSD)*. Explore how the *'Autocorrelation Function'* (ACF) of any power signal can be derived from its PSD. Consider the signal $f(t) = A\cos(\omega_o t + \phi)$. Examine the effect of the phase ϕ on the ACF of *f(t)*.	3+3+2
(b)	Two non-interacting linear time-invariant systems with impulse responses *g(t)* and *h(t)* as shown in Fig. [C], are in cascade. Obtain the impulse response of the combination, performing time-domain operation. *Any appropriate property of convolution may be used for this purpose.*	8
	 Fig. [C]	
5.	Write short notes on any two of the following.	8+8
(a)	Frequency response of 2nd order LTI systems.	
(b)	Impulse function, its approximations and properties.	
(c)	Determination of frequency spectra of unit dc, signum function and unit step.	
(d)	Parseval's formula and energy spectral density.	

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B. ELECTRICAL ENGINEERING 2ND YEAR 2ND SEMESTER EXAMINATION, 2018

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 whether the system characterized by the differential equation $\ddot{y}(t) - \dot{y}(t) + 2y(t) = x(t)$ is stable or not? Assume zero initial conditions.	5
	(b)	The response of an LTI system to a step input, $u(t)$, is $y(t) = (1 - e^{-2t})u(t)$. Find the response of the system to an input $x(t) = 4u(t) - 4u(t-1)$.	5
	(c)	Find state equations for the following system $\ddot{y}(t) + 2\dot{y}(t) + 4y(t) = 2u(t)$.	5
	(d)	Find an analog simulation that converts feet into inches utilizing the full amplifier range of 0 to +10 volts and is capable of converting up to 5feet.	5
Q2	(a)	Obtain the expression for unit step response, in time domain, for a second order underdamped system.	8
	(b)	When the system shown in Figure Q2(a) is subjected to a unit-step input, the system output responds as shown in Figure Q2(b). Determine the values of K and T from the response curve.	12

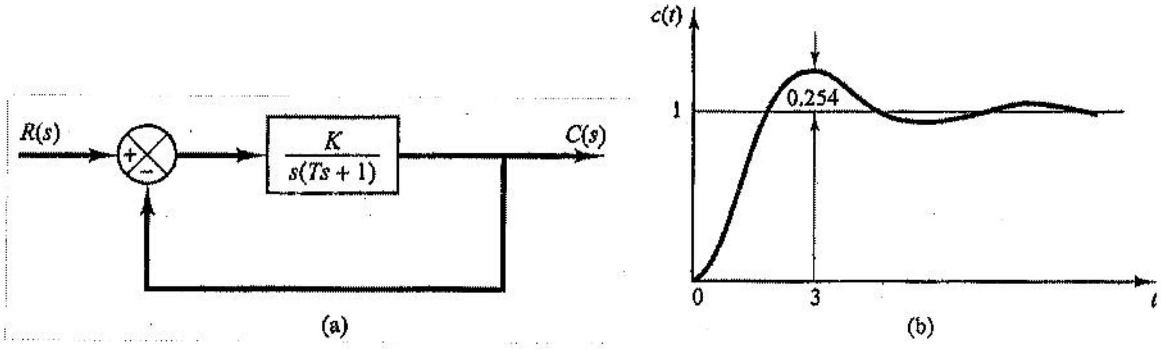

Figure Q2

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Q3 (a) Draw an asymptotic Bode magnitude plot for the system 8

$$G(s) = \frac{10s}{(s+1)(s+5)^2}$$

(b) Stating the simplifying assumptions obtain the transfer function of an armature controlled d. c. motor driving a load with viscous friction. Develop the block diagram for the system. 8+4

Q4 (a) Define state and output equation for an LTI system. 2+2

(b) Consider an LTI system given by the transfer function: 8+4

$$G(s) = \frac{s^2 + 7s + 2}{s^3 + 9s^2 + 26s + 24}$$

Obtain the state-space model of the system in the phase variable canonical form. Draw the corresponding block diagram indicating the individual states.

(c) Find the initial value of $\frac{df(t)}{dt}$ for $F(s) = \mathfrak{L}[f(t)] = \frac{2s+1}{s^2+s+1}$ 4

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

$$\ddot{x} + 8\dot{x} + 25x = 500, \quad x(0) = 40, \dot{x}(0) = 150,$$

$$\text{with, } |x|_{max} = 50, \ |\dot{x}|_{max} = 250.$$

(b) Obtain the transfer function, $E_o(s)/E_i(s)$, for the bridged-T-network shown in Figure Q5. 8

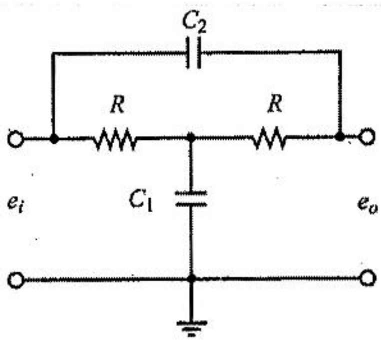

Figure Q5