Ref No: EX/EE/PC/B/T/224(O)/2024

B. E. ELECTRICAL ENGINEERING 2ND YEAR 2ND SEMESTER EXAMINATION, 2024

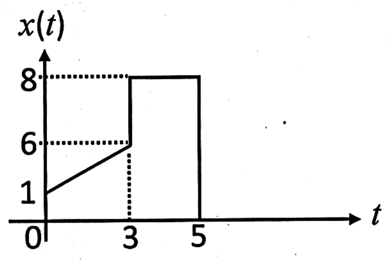
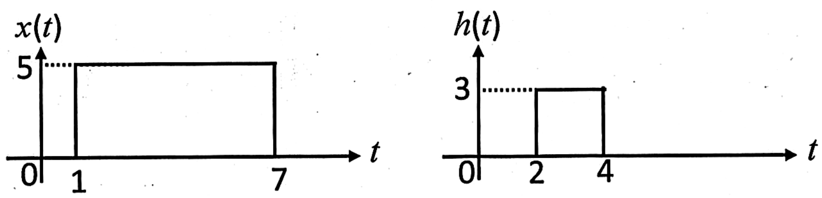
(Old Syllabus)

SUBJECT: - SIGNALS AND SYSTEMS

Full Marks 100
(50 marks for each part)

Time: **Three hours**

Use a separate Answer-Script for each part

No. of Questions	**PART I**	**Marks**
	Answer any **Five**	
1.	Derive an expression of the Complex form of Fourier series for a periodic signal. Hence, define magnitude spectrum and phase spectrum.	10
2.	Determine the Fourier Transform of (a) $x(t) = e^{-5\|t\|}cos100\pi t$ (b) $y(t) = [u(t+3) - u(t-3)]$	5+5
3.	(a) Find graphically the even and odd component of the signal shown in Fig-A.  Fig-A.	7
	(b) Express $x(t)$, shown in Fig-A, in terms of singularity functions.	3
4.	 Fig-B.	

[Turn over

Ref No: EX/EE/PC/B/T/224(O)/2024

	Perform graphically the convolution between the signals *x(t)* and *h(t)*, shown in Fig-B, in time domain. Sketch the resulting signal.	10
5.	(a) Find the energy associated with the signal $x(t)$, shown in Fig-A.	5
	(b) State Parseval's theorem applied to periodic signal. Prove the same.	5
6.	Write short notes on any **one**:	10
	(a) Properties of Impulse function. (b) Frequency response of a second order LTI system.	
7.	(a) Two signals $x(t)$ and $f(t)$ are related as $f(t) = \frac{1}{3}[x(5t) - 4]$. Express energy of $x(t)$ in terms of the energy of $f(t)$.	6
	(b) Define duty cycle and crest factor of an ac coupled rectangular pulse.	4

Ref. No.: Ex/EE/PC/B/T/224(O)/2024

B. E. ELECTRICAL ENGINEERING 2ND YEAR 2ND SEMESTER EXAMINATION, 2024

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

(Old Syllabus)

Part II (50 marks)

Question No.	**Question 1 is compulsory** Answer ***Any Two*** questions from the rest (2×20)	Marks
Q1	Answer ***any Two*** of the following:	
	(a) Determine if the following system $$\dot{y}(t) + 4y(t) = 2x(t)$$ is (i) time-invariant, (ii) linear, (iii) causal, and/or (iv) memoryless?	5
	(b) 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
	(c) The unit impulse response of an LTI system is the unit step function $u(t)$. Find the response of the system to an excitation $e^{-at}u(t)$.	5
	(d) Determine the analog diagram to implement the following differential equation $$\dot{x}(t) + 0.1x(t) = 1,\ x(0) = 0.$$	5
Q2	(a) For a standard 2nd order system derive the expression for unit step response for (i) un-damped, (ii) critically damped conditions. Show the respective pole locations in the s-plane.	4+4
	(b) Consider a mechanical system shown in Figure Q2(b). Assume that the system is linear. The external force $u(t)$ is the input to the system, and the displacement $y(t)$ of the mass is the output. The displacement $y(t)$ is measured from the equilibrium position in the absence of the external force.	
	(a) Derive the transfer function of the system.	4
	(b) Obtain the analogous electrical network based on *force-voltage* analogy	4
	(c) Develop a State-Space Model of the System.	4

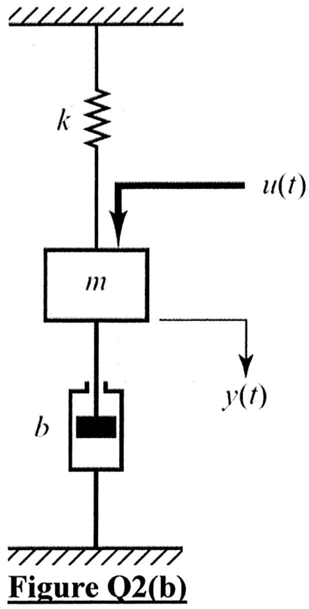


Figure Q2(b)

Ref. No.: Ex/EE/PC/B/T/224(O)/2024

Q3 (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

$$\ddot{x} + 2\dot{x} + 25x = 500, \qquad x(0) = 20, \dot{x}(0) = 0,$$
$$\text{with, } |x|_{max} = 20, \ |\dot{x}|_{max} = 100.$$

(b) Stating the simplifying assumptions obtain the block diagram of an armature controlled d. c. motor driving a load with viscous friction. 8

Q4 (a) State and prove the Final Value Theorem for Laplace Transformation. 4

(b) Solve the following differential equations using the Laplace Transform method 8

$$\ddot{y} + 9\dot{y} + 20y = x$$
$$\text{with, } x(t) = 2u(t) \ (u(t)\text{: unit step}), y(0) = 1, \dot{y}(0) = -2$$

(c) 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. 4

(ii) Draw the nature of the unit step response and indicate the following indices: Rise Time, Peak-Time, Peak Overshoot and Steady-State Value. 4

Q5 (a) Define state and output equations for an LTI system. 4

Draw the block diagram representation of the state and the output equations. 4

(b) Find the transfer function, $Y(s)/X(s)$, for the circuit shown in Figure Q5(b). Calculate the values of ξ and ω_n for C_1=C_2=100μF, R_1=R_2=2000Ω. 8+4

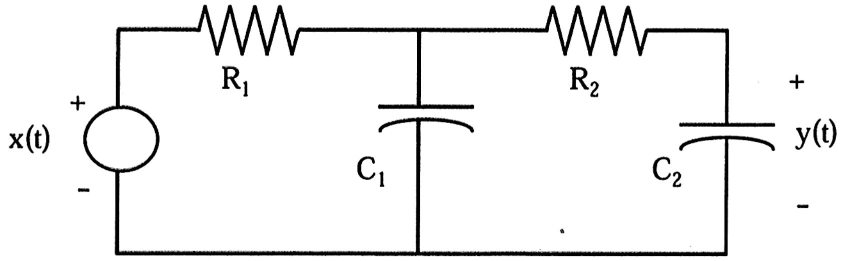


Figure Q5(b)