B.E.ELECTRICAL ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAMINATION, 2024

SIGNALS AND SYSTEMS

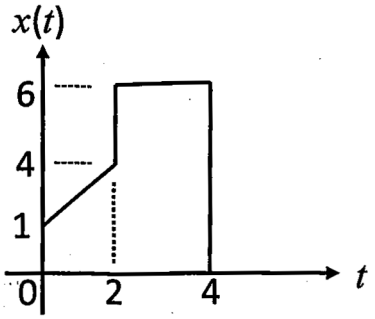
Full Marks 100

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

Use a separate Answer-Script for each part

Question No.	PART I	Marks
	Answer Question No. 5 and any TWO from rests.	
1. (a)	Derive an expression of the exponential form of Fourier series from its trigonometric form. Hence define double sided amplitude spectrum and phase spectrum of a periodic signal.	10
(b)	Show that the power of a periodic signal is the sum of the power of its dc component and ac component.	6
2. (a)	The impulse response of an LTI system is $h(t) = r(t) - r(t-2) - 2u(t-4).$ Apply graphical method in time domain to find out the response of the system when it is excited by an input $x(t) = u(t) + 2u(1-1) - 3u(t-2).$	12
(b)	Given the impulse response of the LTI system as $h(t) = r(t) - r(t-2) - 2u(t-4)$ Find its DC gain. Justify your solution.	4
3. (a)	Find the Fourier Transform of (i) Unit step function (ii) $x(t) = \frac{1}{1+j4\pi t}$	6+5
(b)	Show that the Fourier transform of the odd component of a real signal has imaginary component only with odd symmetry in frequency domain.	5

Ref No: **Ex/EE/PC/B/T/211/2024(S)**

4. (a)	Given a function as shown below:  Fig-A Find the even and odd components of $x(t/3)$ showing all intermediate steps of graphical methods of processing.	**10**
(b)	Find the energy or power, whichever applicable, of the signal shown in Fig-A.	**6**
5.	Write short notes on *any* TWO of the following. (a) Properties of Fourier Transform. (b) Power signals and Energy signals. (c) Impulse function and its properties.	**9+9**

Ref. No.: Ex/EE/PC/B/T/211/2024(S)

B. E. ELECTRICAL ENGINEERING 2ND YEAR 1ST SEMESTER

SUPPLEMENTARY EXAMINATION, 2024

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

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 whether the system characterized by the differential equation $\ddot{y}(t) + 2\dot{y}(t) + 2y(t) = x(t)$ 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) Suggest 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) For a standard 2nd order system find the expressions for unit step response for (i) un-damped and (ii) critically damped conditions. 4+4

(b) Obtain the transfer function, $Y(s)/X(s)$, for the circuit shown in Figure Q2(b). Find the values of ξ and ω_n for C_1=C_2=100μF, R_1=R_2=2000Ω. 8+4

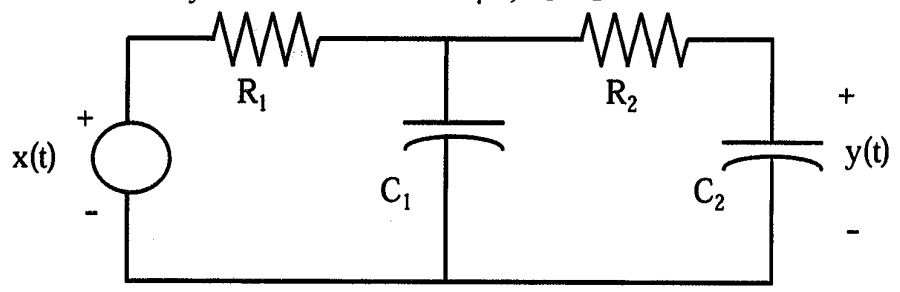


Figure Q2 (b)

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

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

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

(b) State and prove the *Final Value Theorem* and *Initial Value Theorem* for Laplace Transform. 4+4

Q4 (a) Consider a mechanical system shown in Figure Q4(a).

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.

(i) Derive the transfer function of the system. 4

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

(iii) Determine the state-space model in phase variable canonical form. 4

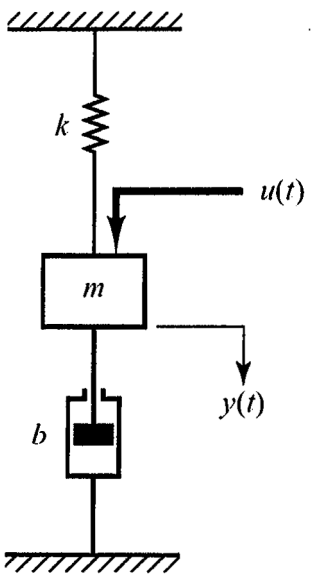


Figure Q4(a)

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

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

Q5 (a) Obtain the transfer function $C(s)/R(s)$ for the system shown in Figure Q5(a) using block diagram reduction technique. 8

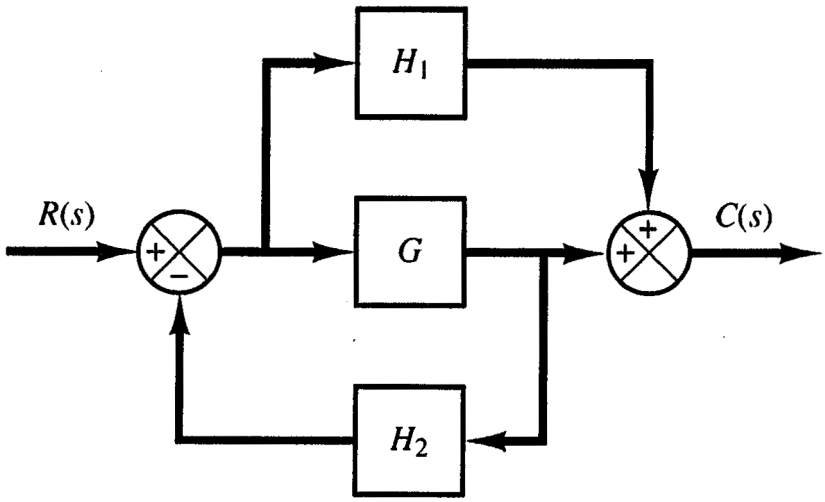


Figure Q5(a)

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

Develop the block diagram for the system. 4