

**BACHELOR OF ENGINEERING ( ELECTRICAL ENGINEERING )**  
**SECOND YEAR SECOND SEMESTER EXAMINATION 2024**  
**SIGNALS AND SYSTEMS**

Full Marks 100

Time: Three hours

(50 marks for each part)

Use a separate Answer-Script for each part  
**PART I**

Answer any **THREE** questions  
 Two marks reserved for neatness

- 1 (a) Sketch the derivative of the signal  $x(t)$  shown in Fig. [A]. Express  $x(t)$  in terms of singularity functions. 8

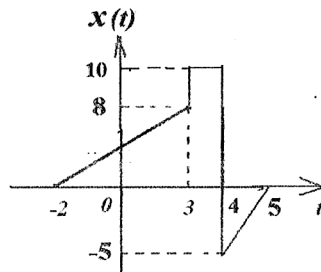
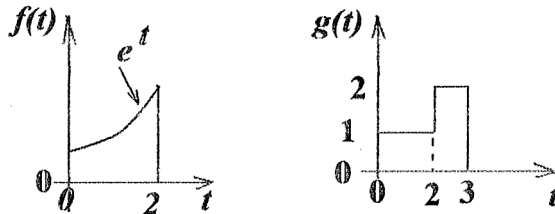


Fig. [A]

- (b) Define “Energy” and “Power” of signals.  
 Determine the energy of the signals  $f(t)$  and  $g(t)$  shown in Fig. [B].



2+6

Fig. [B]

2. Write short notes on any two of the following.

- (a) Impulse function and its properties.  
 (b) Parseval’s formula for energy signals.

8+8

[ Turn over

(c) Fourier transforms and spectra of unit dc, signum function and unit step.

(d) Duty cycle and crest factor of periodic train of rectangular pulses.

3. (a) Convolve the signals shown in Fig.[C] graphically and sketch the result of convolution. 10

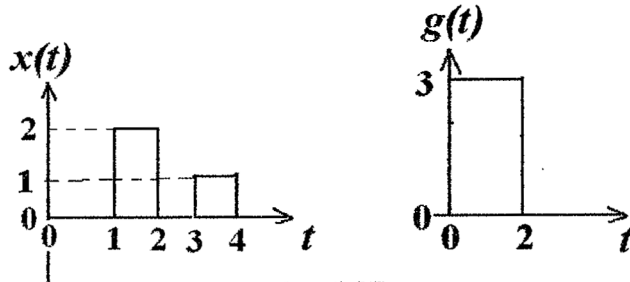


Fig. [C]

- (b) Derive the expression for the Fourier transform of the signal  $m(t)$  shown in Fig. [D], in terms of Sinc functions of frequency. *Knowledge of Fourier transforms of standard functions and properties of Fourier transforms may be used for this purpose.* 6

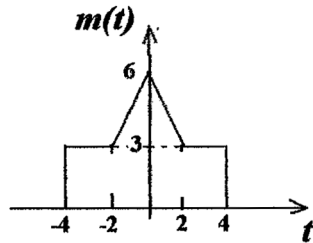


Fig. [D]

4. (a) Determine the exponential Fourier series coefficients and sketch the two-sided amplitude spectrum and two-sided phase spectrum for the signal  $f(t)$  shown in Fig. [E], up to 5<sup>th</sup> harmonic. 10

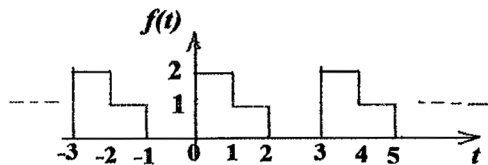


Fig. [E]

- (b) Explain how the concept of the Exponential Fourier series be introduced from the trigonometric Fourier series. 6

5. (a) Decompose the signal  $h(t)$  shown in Fig. [F] into odd and even components.

10

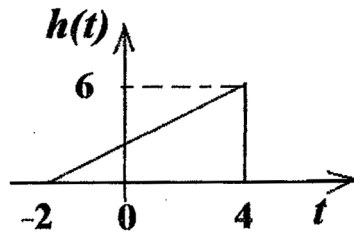


Fig. [F]

(b) Give well-labeled sketches of the following, where  $h(t)$  is the signal shown in Fig. [F].

(i)  $2 h(t/2)$

(ii)  $h(3t-1)$

(iii)  $h[3(t+1)]$

6

**B. E. (ELECTRICAL ENGINEERING) 2<sup>ND</sup> YEAR 2<sup>ND</sup> SEMESTER EXAMINATION, 2024**

**Subject: SIGNALS & SYSTEMS**

**Time: Three Hours**

**Full Marks: 100**

**Part II (50 marks)**

<b>Question No.</b>	<b><u>Question 1 is compulsory</u></b>	<b>Marks</b>
	<b><u>Answer <i>Any Two</i> questions from the rest (2×20)</u></b>	

Q1 Answer *any Two* of the following:

(a) Determine if the system  $\dot{y}(t) + 10y(t) = 5x(t)$  is time-invariant, linear, causal, and/or memoryless? 5

(b) Find the transfer function of the system characterized by the following differential equation (Assume zero initial condition) 5

$$\dot{y} + ay = x.$$

(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 simulation diagram to implement the following differential equation 5

$$\dot{x}(t) + 0.1x(t) = 1, x(0) = 0.$$

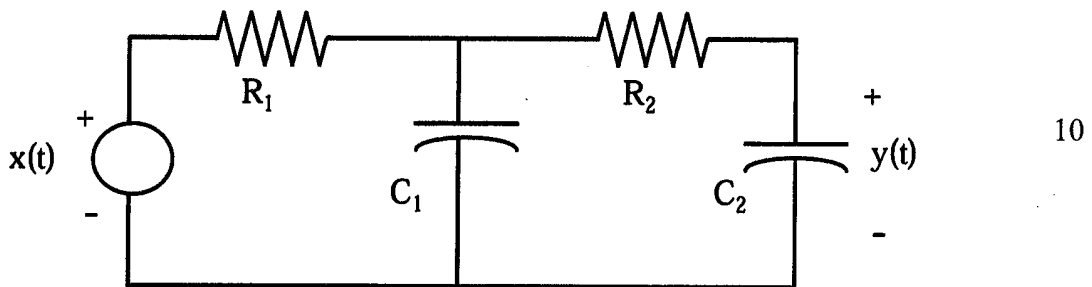
Q2 (a) (i) Define damping ratio ( $\zeta$ ) and undamped natural frequency ( $\omega_n$ ) for a second order system? 2+2

(ii) Given the following system:

$$G(s) = \frac{10}{s^2 + 10s + 100} \quad \text{6}$$

Show the pole locations and find the corresponding values of  $\zeta$  and  $\omega_n$ .

(b) Find the transfer function,  $Y(s)/X(s)$ , for the circuit shown in Figure Q2(b). Consider the following values  $C_1=C_2=100\mu\text{F}$ ,  $R_1=R_2=2000\Omega$ .



**Figure Q2(b)**

- Q3 (a) State and prove, with necessary assumptions, the “Final Value Theorem” for Laplace Transformation. 4
- (b) Use one-sided Laplace Transform to find the output  $y(t)$  of a system given by
- $$\frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = 0$$
- with  $y(0^+) = 3, \dot{y}(0^+) = 1$ . 6
- (c) Draw an asymptotic Bode magnitude plot for the system
- $$G(s) = \frac{10s}{(s+1)(s+5)}$$
- 10
- Q4 (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
- $$\ddot{x} + 4\dot{x} + 10x = 0, \quad x(0) = 50, \quad \dot{x}(0) = 0,$$
- with,  $|x|_{max} = 25, |\dot{x}|_{max} = 100$ .
- (b) Stating the simplifying assumptions obtain the block diagram of an armature controlled d. c. motor driving a load with viscous friction. 8
- Q5 (a) Define state and output equation for an LTI system. 2+2
- Indicate the order of the vectors and the matrices involved in State and Output equations for an  $n$ -th order LTI system with  $p$  inputs and  $m$  outputs. 4
- (b) For an R-L-C series circuit driven by a constant voltage source obtain the state-space model. Assume the voltage across the capacitor to be the output. 8
- Draw the corresponding block diagram indicating the individual state variables. 4