(b) Obtain the electrical analogous circuit for the mechanical system shown in fig. 5 using force-voltage analogy.

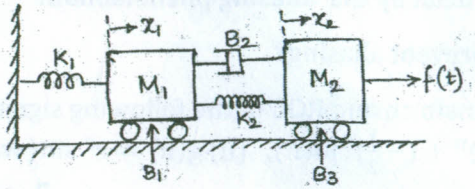

fig. 5

5 + 7 = 12

Group – E

8. (a) Find the state variable model of the circuit shown in fig. 6. Assume $v_1(t)$, $v_2(t)$ are the state variables and $e_0(t)$, $e_i(t)$ are the output and input to the system respectively.

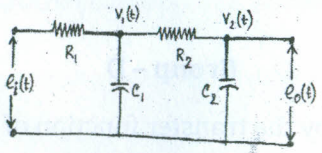

fig. 6

(b) Construct the state variable model of an armature controlled dc servo motor. Consider armature voltage as input and angular position of the shaft as output of the system.

6 + 6 = 12

9.(a) A linear system is described by the state equation

$$\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}0 & 1\\ -4 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 2\end{bmatrix}u \quad \text{and} \quad y = [0 \quad 1]\begin{bmatrix}x_1\\ x_2\end{bmatrix}.$$

Find the transfer function of the system.

(b) A continuous time system is described by the state equation

$$\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u \quad \text{and} \quad y = [0 \quad 1]\begin{bmatrix}x_1\\ x_2\end{bmatrix}.$$

Find

(i) state transition matrix

(ii) zero input response if $x_1(0) = 1, x_2(0) = 0$

(iii) unit step response of the system.

4+ (3 +1 + 4) = 12

SIGNALS & SYSTEMS
(ELEC 3103)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) The value of the integral $\int_{-\infty}^{\infty} \delta(t)\cos\left(\frac{3t}{2}\right) dt$ is

(a) 1 (b) −1 (c) 0 (d) $\frac{\pi}{2}$.

(ii) If a signal f(t) has energy E, then the energy of the signal f(3t) is equal to

(a) E (b) E/3 (c) 3E (d)6E.

(iii) Integration of a unit step signal is a

(a) unit ramp signal (b) unit impulse signal

(c) unit parabolic signal (d) gate signal.

(iv) A signal $x(t) = A\cos(\Omega t + \beta)$ is

(a) an energy signal

(b) a power signal

(c) an energy as well as a power signal

(d) neither energy nor a power signal.

(v) If a periodic signal has an odd symmetry, then the Fourier series contains

(a) only sine terms (b) only cosine terms

(c) constant and cosine terms (d) both sine and cosine terms.

(vi) In force-voltage analogy, mass is analogous to

(a) resistance (b) inductance

(c) capacitance (d) conductance.

(vii) The unit step response of the system $G(s) = \frac{10}{0.4s+1}$ reaches 98% of its final value after

(a) 1.2 sec (b) 2 sec (c) 1.6 sec (d) 0.4sec.

(viii) The time response of a second order system gives critically damped characteristics if damping factor is
(a) 1 (b) 0.707 (c) less than 0.707 (d) less than 1.

(ix) For a single input, 3 state and 2 output system, the dimension of C matrix is
(a) 3 × 3 (b) 2 × 3 (c) 3 × 2 (d) 4 × 1.

(x) A second order system has $A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$, the system is
(a) underdamped (b) overdamped
(c) critically damped (d) undamped.

Group - B

2. (a) Examine whether $x(t) = 2e^{-4t}$ is an energy signal or a power signal.

(b) Sketch $x(-2t+2)$ if $x(t) = 1.5t$ for $0 \le t < 2$
$= 0$ elsewhere

(c) Find the even and odd component of the sequence:

$x(n) = \{4, -2, \underset{\downarrow}{\hat{4}}, -6\}$

(d) Express the following signal x(t) as shown in fig. 1, in terms of singularity functions.

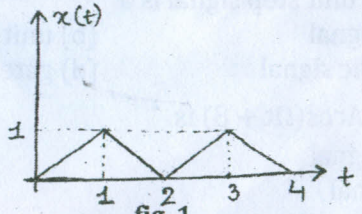

fig. 1

2 + 2 + 2 + 6 = 12

3. (a) Find the Fourier series of the signal x(t) shown in fig. 2.

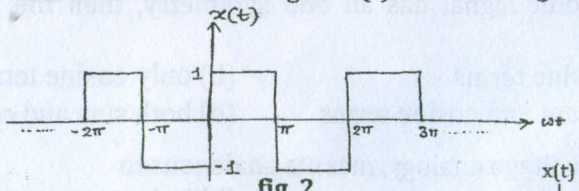

fig. 2

(b) Find the Fourier transform of the signal x(t) shown in fig. 3. Also sketch the amplitude and phase spectrum of the signal.

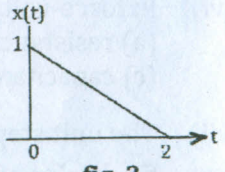

fig. 3

6 + (4 + 2) = 12

Group - C

4. (a) What do you mean by the aliasing phenomenon?

(b) How can we prevent aliasing?

(c) Find the Z-transform and ROC of the following signals.
(i) $x(n) = [(\frac{2}{3})^n + (-\frac{1}{2})^n]u(n)$, (ii) $g(n) = r^n \sin(w_0 n)\, u(n)$

2 + 2 + (4 + 4) = 12

5. (a) Find the inverse z-transform of $X(z) = \frac{z^2}{(z-\frac{1}{4})(z-\frac{1}{2})}$.

(b) Find the unit step response of the system whose input(x(n)) and output(y(n)) relationship is given by the difference equation
$y(n) = \frac{1}{2}y(n-1) + 2x(n)$

6 + 6 = 12

Group – D

6. (a) What do you mean by the transfer function of a system?

(b) A system is described by a differential equation,
$\frac{d^2y}{dt^2} + 8\frac{dy}{dt} + 25\,y(t) = 25\,x(t)$
where y(t) is the output and x(t) is the input to the system.
Find out :
(i) transfer function of the system
(ii) natural frequency of oscillation and damping ratio of the system
(iii) unit step response of the system
(iv) peak time, over shoot and settling time of the system
(v) sketch the Unit step response of the system.

2 + (1 + 2 + 3 + 3 + 1) = 12

7. (a) Write the differential equation relating $e_o(t)$ & $e_i(t)$ for the circuit shown in fig. 4 and find out $\frac{E_o(s)}{E_i(s)}$.

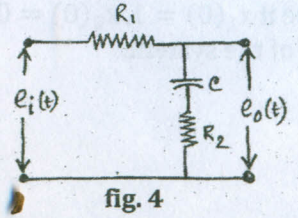

fig. 4