SIGNALS & SYSTEMS
(ELEC 2202)

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 odd and even components of the sequence $x(n) = \{1, \underset{\uparrow}{2}, 5\}$ are respectively

(a) $\{2, \underset{\uparrow}{0}, 2\}, \{5, \underset{\uparrow}{2}, 1\}$ (b) $\{6, \underset{\uparrow}{4}, 6\}, \{-4, \underset{\uparrow}{0}, 4\}$

(c) $\{-4, \underset{\uparrow}{0}, 4\}, \{6, \underset{\uparrow}{4}, 6\}$ (d) $\{1, \underset{\uparrow}{2}, 5\}, \{5, \underset{\uparrow}{2}, 1\}$

(ii) If a signal f(t) has energy E, the energy of the signal f(4t) is equal to

(a) E (b) E/4

(c) 2E (d) 4E

(iii) The differentiation of an impulse signal is

(a) doublet signal (b) step signal

(c) parabolic signal (d) gate signal

(iv) The value of $\int_{-\infty}^{\infty} e^{-t}\delta(2t-2)\,dt$ is

(a) $\frac{1}{2e}$ (b) $\frac{2}{e}$

(c) $\frac{1}{e^2}$ (d) $\frac{1}{2e^2}$

(v) Fourier transform of a gate signal is

(a) sine wave (b) sinc function

(c) unit step signal (d) impulse signal

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

(a) resistance (b) inductance

(c) capacitance (d) conductance

(vii) The unit step input is given to a system having transfer function $G(s) = \frac{25}{s^2+6s+25}$. The peak time of the system is

(a) 0.35 sec (b) 0.58 sec

(c) 0.79 sec (d) 0.96 sec

(viii) The unit step response of the system $G(s) = \frac{1}{0.2s+1}$ reaches 63.2% of its final value after .

(a) 20 sec (b) 0.2 sec
(c) 2 sec (d) 1sec

(ix) For a one input, three state and two output system, the dimension of B matrix is

(a) 3 × 2 (b) 3 × 1
(c) 1 × 3 (d) 2 × 3

(x) A system has system matrix $A = \begin{bmatrix} 0 & 0 \\ -1 & -2 \end{bmatrix}$, pole location of the system will be at

(a) $s = 1$ and $s = -1$ (b) $s = -1$ and $s = -2$
(c) $s = 0$ and $s = -2$ (d) $s = 2$ and $s = -2$

Group – B

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

(b) Sketch the signal $f(t) = r(t+2) - r(t+1) - r(t-2) + r(t-3)$.

(c) Find out $x(2n-1)$ if $x(n) = \{1,6,\overset{\downarrow}{\overset{\frown}{2}},0,3\}$.

(d) Find the even and odd component of a unit ramp signal.

(e) Determine the graphical convolution of the following two signals $x(t) = u(t-3) - u(t-5)$ and $h(t) = u(t) - u(t-2)$.

3 + 2 + 1 + 2 + 4 = 12

3 (a) Determine the Trigonometric Fourier series for the signal $x(t)$ shown in Fig. 1. Hence find out the exponential Fourier series coefficients.

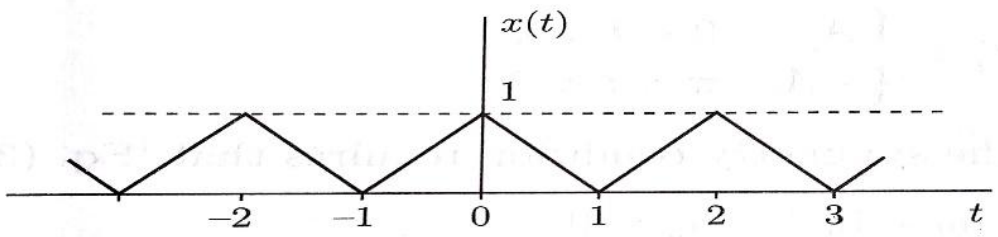

Fig. 1

(b) Find the Fourier transform of the signal $g(t)$ shown in Fig. 2. Also sketch the amplitude spectrum of the signal.

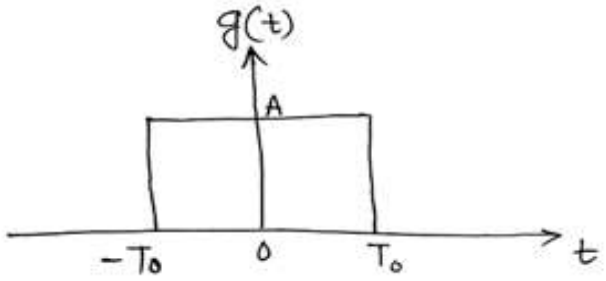

Fig. 2

(5 + 2) + 5 = 12

Group – C

4. (a) State sampling theorem.

   (b) Discuss aliasing phenomenon with an example.

   (c) Find the Z-transform and ROC of the following signals.
   (i) $x(n) = a^{|n|}; |a| < 1$
   (ii) $g(n) = \mathrm{r}^{\mathrm{n}}\cos(\omega_0 n)\, u(n)$
   (iii) $x(n) = [(\frac{2}{3})^n + (-\frac{1}{2})^n]u(n)$.

1 + 2 + 9 = 12

5 (a) Find the inverse z-transform by partial fraction method of the following functions.

(i) $X(z) = \frac{5z^{-1}}{(1-2z^{-1})(1-3z^{-1})}$, ROC $|z| < 2$

(ii) $X(z) = \frac{z^2}{(z-2)(z-4)}$, ROC $|z| > 2$

(iii) $X(z) = \frac{8z-19}{z^2-5z+6}$, ROC $|z| > 3$

(b) Find the impulse response of the system whose input$(x(n))$ and output$(y(n))$ relationship is given by the difference equation

$$y(n) = 2y(n-1) - 3y(n-2) + x(n) - x(n-2).$$

9 + 3 = 12

Group – D

6. A system is described by the equation $\frac{d^2y(t)}{dt^2} + 2\frac{dy(t)}{dt} + 10y(t) = 10x(t)$ where $x(t)$ and $y(t)$ are the input and output respectively. Determine the (i) transfer function (ii) damping factor and natural frequency (iii) unit step response (iv) peak overshoot (v) settling time (2% tolerance band) (vi) resonant frequency and (vii) resonant peak of the system. Also sketch the unit step response of the system.

(10 + 2) = 12

7. What do you mean by analogues system? Obtain the force equilibrium equation for the mechanical system shown in fig. 3. Hence, draw the force-voltage and force-current analogues circuit.

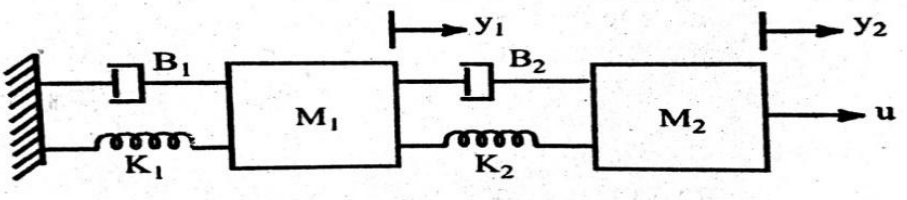

Fig. 3

(1 + 3 + 4 + 4) = 12

Group – E

8. (a) Construct the state variable model of the system shown in fig. 4.

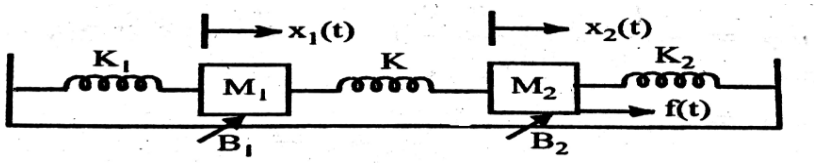

Fig. 4

(b) Find the state variable model of the system whose transfer function is given by

$$G(s) = \frac{s^2+7s+6}{s^5+3s^4+5s^3+8s^2+7s+14}$$

6 + 6 = 12

9. The state variable model of a system is given by,

$$\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 2\end{bmatrix}u \text{ and } y = [1 \quad 0]\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

Find (i) Transfer function of the system.
(ii) State transition matrix
(iii) Zero input response if $x_1(0)=1$ and $x_2(0)=1$.
(iv) The state response due to unit impulse input and
(v) The time response y(t).

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

Department & Section	Submission Link
EE (Regular & Backlog)	https://classroom.google.com/c/MTIxOTk2MTM4MTk3/a/MzU5MzM2NDc4OTYx/details