GATE QUESTIONS

Dronacharya College of Engineering, Gurgaon

Subject : Signals and System **Branch ECE/EEE**

Year 2021

Q1. The Exponential Fourier Series representation of a continuous -Time periodic Signal x(t) is define as

$$x(t) = \sum_{k=-\infty}^{\infty} a_k \, e^{jkw_0 t}$$

Were ω_0 is the fundamental angular frequency of x(t) and the Coefficients of the series are a_k.The following information is given about x(t) and a_k.

i. **X(t) is real and even ,having a fundamental period of 6**
ii. **The average value of x(t)is 2**
iii. $a_k = \begin{cases} k & 1 \le k \le 3 \\ 0, & k > 3 \end{cases}$

The average power of the signal x(t) (rounded off to one decimal place)

Q2. For a unit step input u[n], a discrete -time LTi system produces an output signal$(2\delta[n+1] + \delta[n-1])$. Let y[n] be the output of the system for an input $((1/2)\hat{}n + u[n])$. The value of y[0] is

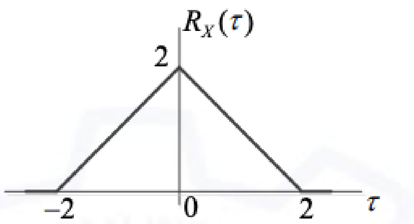
Q3. Consider the signals $x[n] = 2\hat{}(n-1)\, u[-n+2] and y[n] = 2\hat{}(-n+2)\, u[n+1]$ Where u[n] is the unit step sequence. Let$X(e\hat{}j\omega\,) and\ Y(e\hat{}j\omega\,)$ be the discrete time fourier transform of x[n] and y[n],respectively. The value of the integral

$$\frac{1}{2\pi}\int_0^{2\pi} (e^{j\omega})\, Y(e^{j\omega}) dw$$

Rounded off to one decimal Place is

Q4.Consider two 16-point sequences $[n]$ and $h[n]$. Let the linear convolution of $[n]$ and $h[n]$ be denoted by $y[n]$, while $z[n]$ denotes the 16-point inverse discrete Fourier transform (IDFT) of the product of the 16-point DFTs of $x[n]$ and $h[n]$. The value(s) of k for which $[k]$ = $y[k]$ is/are
A) K=0,1,2---15 B)k=0 C)k=15 D)K=0 and 15

Q5 The autocorrelation function $R(\tau)$ of a wide-sense stationary random process $X(t)$ is shown in the figure.



Q6.**If the input x(t) and output y(t) of a system are related as y(t)=max(0,x(t)), the the system is A)linear and Time Variant B) linear and Time Invariant C)Non- linear and Time Variant D) Non linear and Time – Invariant.**

Q7 Two discrete-time linear time invariant system with impulse response $h\_1\,[n] = \delta[n-1] + \delta[n+1] and h\_2\,[n] = \delta[n] + \delta[n-1]$ are connected in cascade, where $\delta[n]$ is the Kronecker delta .The impulse response of the cascaded system is

A) $\delta[n-2]+\delta[n+1]$ B) $\delta[n-1]\delta[n]+\delta[n+1]\delta[n-1]$
C) $\delta[n-2]+\delta[n-1]+\delta[n]\delta[n+1]$ D) $\delta[n-1]\delta[n]+\delta[n+1]\delta[n-2]$

Q8. The Causal Signal with z-transform z^2 (〖$z-a$)〗 ^2 $is\ (u[n] is\ the\ unit\ step\ signal)$

A) a^$2n\ u[n]$
B) 〖$(n+1)a$〗 ^$n\ u[n]$
C) n^$(-1)\ a$^$n\ u[n]$
D) n^$2\ a$^$n\ u[n]$

Q9 Let f(t) be an even function ,i.e f(-t)=f(t) for all t.Let the Fourier transform of f(t) be defined as $F(\omega)=\int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt\ .Suppose \frac{dF(\omega)}{d\omega}=-\omega F(\omega) for\ all\ \omega, and\ F(0)=1$

A) f(0)< 1 B) f(0)> 1 C f(0)=1 D) f(0)= 0

Q10.Consisder a continuous _time signal x(t) defined by x(t)=0 for $|t|>1, and\ x(t)=1-|t|\ \ for\ |t|\leq 1$**.Let the fourier transform of x(t) be defined as** $X(\omega)=\int_{-\infty}^{\infty} x(t)e^{-j\omega t}dt$**.The magnitude of X(w) is**

Year 2020

Q11 The output y[n] of a discrete-time system for an input x[n] is $y[n]=$ 〖max〗 _$(-\infty\leq k\leq n)\ |x[k]|$
The unit impulse response of the system is

A) O for all n B) 1 for all n C) unit step signal u[n] D) unit impulse signal $\delta[n]$

Q12. Let Y(s) be the unit -step response of a causal system having transfer function

$$G(s)=(3-s)/((s+1)(S+3))\ \ that\ \ is\ Y(s)=\ \ (G(s))/s.$$

The forced response of the system is

A) $u(t)-2e$^$(-t)\ u(t)+e$^$(-3t)\ u(t)$ B) $2u(t)-2e$^$(-t)\ u(t)+e$^$(-3t)\ u(t)$
C) $2u(t)$ D)$u(t)$

Q13. Let $X[k]=k+1, 0\leq k\leq 7$ **be 8-point DFT of a sequence x[n] where**

$$X[k]=\sum_{n=0}^{N-1}〖x(n)〗e^{-J\frac{2\pi nk}{N}}$$

The value correct of two decimal place of $\sum_{n=0}^{3} x[2n]$ **is**

Q14.A finite duration discrete signal x[n] is obtained by sampling the continuous-time signal x(t)= cos(200 πt) at the sampling of t=n/400 n=0,1,2---7.The 8 point DFT of x[n] is defined as

$$X[k]=\sum^{7} x[n]e^{-j\frac{\pi kn}{4}}, \qquad k=0,1,\cdots,7.$$

Which of the statement is True ?
a) All X[k] are non-zero
b) only X[4] is non-zero
c)only X[2] and X[6] are non -zero

D) only X[3] and X[5] are non –zero

Q15. Consider a Linear time-invariant system whose input r(t) and output y(t) are related by the following differential equation:

$$\frac{d^2y(t)}{dt^2} + 4y(t) = 6r(t)$$

The poles of this system are at
a)+2j,-2j b)+2,-2 C) +4,-4 d) +4j,-4J

Q16. Which of the following option is true for a linear time-invariant discrete time system that obeys the difference equation:

$$y[n] - ay[n-1] = b_0x[n] - b_1x[n-1]$$

a) y[n] is unaffected by the value of x[n-k]; K> 2.
b) the system is necessarily causal
c) the system impulse response is non-zero at infinitely many instants
d) when x[n]=0,n<o, the function y[n];n>0 is solely determined by the function x[n]

Q17. Consider a signal $x[n] = \left(\frac{1}{2}\right)^n \mathbf{1}[n], \textbf{where } \mathbf{1}[n] = \mathbf{0} \textbf{ if } n < 0, and\ 1[n] = \mathbf{1} \textbf{ if } n \geq \mathbf{0}$

The Z-transform of x[n-k],k>0 is $\frac{z^{-k}}{1-\frac{1}{2}z^{-1}}$ **with region of convergence begin**

a) $|z| < 2$ **b)**$|z| > 2$ **c)** $|z| < \frac{1}{2}$ **d)** $|z| > \frac{1}{2}$

Q18. Suppose for input x(t) a linear time -invariant system with impulse response h(t) produces output y(t),so that x(t)*h(t) = y(t).Further if $|x(t)| * |h(t)| = z(t)$,
Which of the following statement is true ?

(A) For all $t \in (-\infty, \infty)$, $z(t) \leq y(t)$
(B) For some but not all $t \in (-\infty, \infty)$, $z(t) \leq y(t)$
(C) For all $t \in (-\infty, \infty)$, $z(t) \geq y(t)$
(D) For some but not all $t \in (-\infty, \infty)$, $z(t) \geq y(t)$

Q19. The causal realization of a system transfer function H(s) having poles at (2,-1),(-2,1) and zeroes at (2,1),(-2,-2) will be
a) Stable,real,all pass
b)unstable,complex,all Pass.
c)unstable,real,highpass
d) stable,complex,lowpass

Q20 Consider a signal x[n]=(1/2) 1[n] ,where 1[n]=0 if n<0 and 1[n]=1 if n>=0.The Z-transform of x[n-k],k>0 is $\frac{z^{-k}}{1-\frac{z^{-k}}{2}}$ **with region of convergence being**

$\boldsymbol{a})|\boldsymbol{Z}| < 2$
$\boldsymbol{b})|\boldsymbol{Z}| > 2$
$\boldsymbol{c})|\boldsymbol{Z}| < 1/2$
$\boldsymbol{d})|\boldsymbol{Z}| > 1/2$

Q21.Consider a linear time- invariant system whose input r(t) and output y(t) are related by the following differential equation

$$\frac{d^2y(t)}{dt^2} + 4y(t) = 6r(t)$$

The poles are at

a)+2j,-2j b)+2,-2 C)+4,-4 d) +4j,-4j

Year 2019

Q22 Let Y(s) be the unit -step response of a causal system having transfer function

$$G(s) = \frac{3-s}{(s+1)(s+3)}$$

that is, $Y(s) = \frac{G(s)}{s}$. The forced response of the system is

(A) $u(t) - 2e^{-t}u(t) + e^{-3t}u(t)$

(B) $2u(t) - 2e^{-t}u(t) + e^{-3t}u(t)$

(C) $2u(t)$

(D) $u(t)$

Q23 Consider the signal

Where t is in second .Its fundamental time period, in seconds is

$f(t) = 1 + 2\cos(\pi t) + 3\sin\left(\frac{2\pi}{3}t\right) + 4\cos\left(\frac{\pi}{2}t + \frac{\pi}{4}\right)$, where t is in

Q24.

Consider a differentiable function $f(x)$ on the set of real numbers such that $f(-1) = 0$ and $|f'(x)| \leq 2$. Given these conditions, which one of the following inequalities is necessarily true for all $x \in [-2, 2]$?

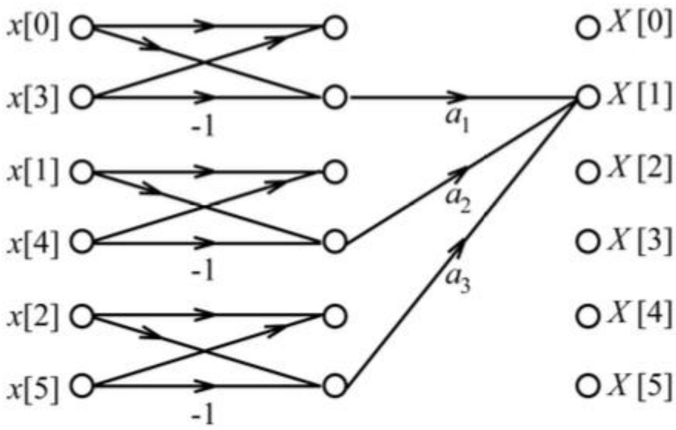
(A) $f(x) \leq \frac{1}{2}|x+1|$

(B) $f(x) \leq 2|x+1|$

(C) $f(x) \leq \frac{1}{2}|x|$

(D) $f(x) \leq 2|x|$

Q25.
Consider a six-point decimation-in-time Fast Fourier Transform (FFT) algorithm, for which the signal-flow graph corresponding to $X[1]$ is shown in the figure. Let $W_6 = \exp\left(-\frac{j2\pi}{6}\right)$. In the figure, what should be the values of the coefficients a_1, a_2, a_3 in terms of W_6 so that $X[1]$ is obtained correctly?



(A) $a_1 = -1, a_2 = W_6, a_3 = W_6^2$
(B) $a_1 = 1, a_2 = W_6^2, a_3 = W_6$
(C) $a_1 = 1, a_2 = W_6, a_3 = W_6^2$
(D) $a_1 = -1, a_2 = W_6^2, a_3 = W_6$

Q26.
The inverse Laplace transform of $H(s) = \frac{s+3}{s^2+2s+1}$ for $t \geq 0$ is

(A) $3te^{-t} + e^{-t}$
(B) $3e^{-t}$
(C) $2te^{-t} + e^{-t}$
(D) $4te^{-t} + e^{-t}$

Q27

The inverse Laplace transform of $H(s) = \frac{s+3}{s^2+2s+1}$ for $t \geq 0$ is

(A) $3te^{-t} + e^{-t}$
(B) $3e^{-t}$
(C) $2te^{-t} + e^{-t}$
(D) $4te^{-t} + e^{-t}$

Q28.
Which one of the following functions is analytic in the region $|z| \leq 1$?

(A) $\frac{z^2-1}{z}$ (B) $\frac{z^2-1}{z+2}$ (C) $\frac{z^2-1}{z-0.5}$ (D) $\frac{z^2-1}{z+j0.5}$

Q29.

The output response of a system is denoted as $y(t)$, and its Laplace transform is given by

$$Y(s) = \frac{10}{s(s^2+s+100\sqrt{2})}.$$

The steady state value of $y(t)$ is

(A) $\frac{1}{10\sqrt{2}}$ (B) $10\sqrt{2}$ (C) $\frac{1}{100\sqrt{2}}$ (D) $100\sqrt{2}$

Q30.

The characteristic equation of a linear time-invariant (LTI) system is given by

$$\Delta(s) = s^4 + 3s^3 + 3s^2 + s + k = 0.$$

The system is BIBO stable if

(A) $0 < k < \frac{12}{9}$ (B) $k > 3$

(C) $0 < k < \frac{8}{9}$ (D) $k > 6$

Q31

A periodic function $f(t)$, with a period of 2π, is represented as its Fourier series,

$$f(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos nt + \sum_{n=1}^{\infty} b_n \sin nt.$$

If

$$f(t) = \begin{cases} A\sin t, & 0 \le t \le \pi \\ 0, & \pi < t < 2\pi \end{cases},$$

the Fourier series coefficients a_1 and b_1 of $f(t)$ are

(A) $a_1 = \frac{A}{\pi}$; $b_1 = 0$ (B) $a_1 = \frac{A}{2}$; $b_1 = 0$

(C) $a_1 = 0$; $b_1 = A/\pi$ (D) $a_1 = 0$; $b_1 = \frac{A}{2}$

YEAR 2018

Q32 The input be *u* and the output be *y* of a system, and the other parameters are real constants. Identify which among the following systems is not a linear system:

(A) $\frac{d^3y}{dt^3} + a_1\frac{d^2y}{dt^2} + a_2\frac{dy}{dt} + a_3 y = b_3 u + b_2\frac{du}{dt} + b_1\frac{d^2u}{dt^2}$ (with initial rest conditions)

(B) $y(t) = \int_0^t e^{\alpha(t-\tau)}\beta u(\tau)d\tau$

(C) $y = au + b, \quad b \neq 0$

(D) $y = au$

Q33. Consider $(s) = s^3 + a_2s^2 + a_1s + a_0$ with all real coefficients. It is known that its derivative $p'(s)$ has no real roots. The number of real roots of (s) is

(A) 0 (B) 1 (C) 2 (D) 3

Q34

Let $f(x,y) = \frac{ax^2 + by^2}{xy}$, where a and b are constants. If $\frac{\partial f}{\partial x} = \frac{\partial f}{\partial y}$ at $x = 1$ and $y = 2$, then the relation between a and b is

(A) $a = \frac{b}{4}$ (B) $a = \frac{b}{2}$ (C) $a = 2b$ (D) $a = 4b$

Q35

A discrete-time all-pass system has two of its poles at $0.25\angle 0^\circ$ and $2\angle 30^\circ$. following statements about the system is TRUE?

(A) It has two more poles at $0.5\angle 30^\circ$ and $4\angle 0^\circ$.
(B) It is stable only when the impulse response is two-sided.
(C) It has constant phase response over all frequencies.
(D) It has constant phase response over the entire z-plane.

Q36
Let $x(t)$ be a periodic function with period $T = 10$. The Fourier series coefficients for this series are denoted by a_k, that is

$$x(t) = \sum_{k=-\infty}^{\infty} a_k\, e^{jk\frac{2\pi}{T}t}$$

The same function $x(t)$ can also be considered as a periodic function with period $T' = 40$. Let b_k be the Fourier series coefficients when period is taken as T'. If $\sum_{k=-\infty}^{\infty} |a_k| = 16$, then $\sum_{k=-\infty}^{\infty} |b_k|$ is equal to

(A) 256 (B) 64 (C) 16 (D) 4

Q37.
The position of a particle $y(t)$ is described by the differential equation:

$$\frac{d^2y}{dt^2} = -\frac{dy}{dt} - \frac{5y}{4}.$$

The initial conditions are $y(0) = 1$ and $\left.\frac{dy}{dt}\right|_{t=0} = 0$. The position (accurate to two decimal places) of the particle at $t = \pi$ is _______.

Q38.

Let $X[k] = k + 1, 0 \leq k \leq 7$ be 8-point DFT of a sequence $x[n]$,

where $X[k] = \sum_{n=0}^{N-1} x[n] e^{-j2\pi nk/N}$.

The value (correct to two decimal places) of $\sum_{n=0}^{3} x[2n]$ is ______.

Q39. The three roots of the equation $(x) = 0$ are $x = \{-2, 0, 3\}$. What are the three values of x for which $(x - 3) = 0$?

1. **(A) −5,−3,0 (B) −2,0,3 (C) 0,6,8 (D) 1,3,6**

Q40

For what values of k given below is $\frac{(k+2)^2}{k-3}$ an integer?

(A) 4, 8, 18
(B) 4, 10, 16
(C) 4, 8, 28
(D) 8, 26, 28

Q41
Consider a system governed by the following equations

$$\frac{dx_1(t)}{dt} = x_2(t) - x_1(t)$$
$$\frac{dx_2(t)}{dt} = x_1(t) - x_2(t)$$

The initial conditions are such that $x_1(0) < x_2(0) < \infty$. Let $x_{1f} = \lim_{t \to \infty} x_1(t)$ and $x_{2f} = \lim_{t \to \infty} x_2(t)$. Which one of the following is true?

(A) $x_{1f} < x_{2f} < \infty$ (B) $x_{2f} < x_{1f} < \infty$ (C) $x_{1f} = x_{2f} < \infty$ (D) $x_{1f} = x_{2f} = \infty$

Q42. The number of roots of the polynomial, $s^7 +$ [illegible] $s^6 + 7s^5 + 14s^4 + 31s^3 + 73s^2 + 25s + 200$, in the open left half of the complex plane is

A) 3 B) 4 C) 5 D) 6

Q43.

If C is a circle $|z| = 4$ and $f(z) = \frac{z^2}{(z^2-3z+2)^2}$, then $\oint_C f(z)dz$ is

(A) 1 (B) 0 (C) -1 (D) -2

Q44.

Consider the two continuous-time signals defined below:

$$x_1(t) = \begin{cases} |t|, & -1 \le t \le 1 \\ 0, & \text{otherwise} \end{cases}, \qquad x_2(t) = \begin{cases} 1-|t|, & -1 \le t \le 1 \\ 0, & \text{otherwise} \end{cases}$$

These signals are sampled with a sampling period of $T = 0.25$ seconds to obtain discrete-time signals $x_1[n]$ and $x_2[n]$, respectively. Which one of the following statements is true?

(A) The energy of $x_1[n]$ is greater than the energy of $x_2[n]$.
(B) The energy of $x_2[n]$ is greater than the energy of $x_1[n]$.
(C) $x_1[n]$ and $x_2[n]$ have equal energies.
(D) Neither $x_1[n]$ nor $x_2[n]$ is a finite-energy signal.

Q45 The signal energy of the continuous-time signal $x(t)=[(t-1)u(t-1)]-[(t-2)u(t-2)]-[(t-3)u(t-3)]+[(t-4)u(t-4)]$ is

(A) 11/3 (B) 7/3 (C) 1/3 (D) 5/3

Q46.

The Fourier transform of a continuous-time signal $x(t)$ is given by $X(\omega) = \frac{1}{(10+j\omega)^2}$, $-\infty < \omega < \infty$, where $j = \sqrt{-1}$ and ω denotes frequency. Then the value of $|\ln x(t)|$ at $t = 1$ is ___________ (up to 1 decimal place). ($\ln$ denotes the logarithm to base e)