GATE EE Topic wise Questions

SIGNALS & SYSTEMS

YEAR 2010 **ONE MARK**

Question. 1

For the system $2/(s+1)$, the approximate time taken for a step response to reach 98% of the final value is

(A) 1 s (B) 2 s

(C) 4 s (D) 8 s

Question. 2

The period of the signal $x(t) = 8\sin\left(0.8\pi t + \frac{\pi}{4}\right)$ is

(A) 0.4π s (B) 0.8π s

(C) 1.25 s (D) 2.5 s

Question. 3

The system represented by the input-output relationship

$$y(t) = \int_{-\infty}^{5t} x(\tau)\, d\tau, t > 0$$

(A) Linear and causal

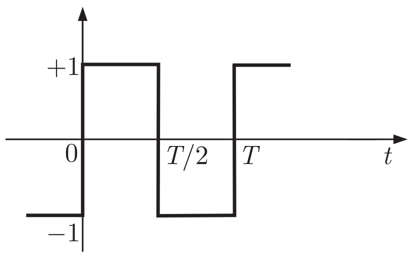
(B) Linear but not causal

(C) Causal but not linear

(D) Neither liner nor causal

Question. 4

The second harmonic component of the periodic waveform given in the figure has an amplitude of



(A) 0

(B) 1

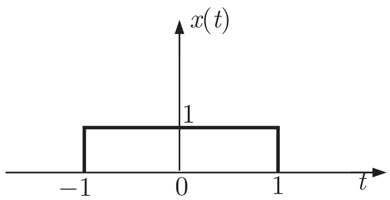
(C) $2/\pi$

(D) $\sqrt{5}$

YEAR 2010 **TWO MARKS**

Question. 5

$x(t)$ is a positive rectangular pulse from $t = -1$ to $t = +1$ with unit height as shown in the figure. The value of $\int_{-\infty}^{\infty} |X(\omega)|^2 d\omega$ {where $X(\omega)$ is the Fourier transform of $x(t)$} is.



(A) 2

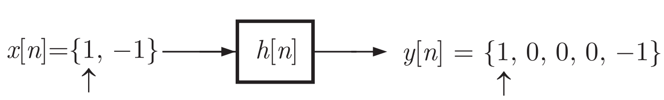
(B) 2π

(C) 4

(D) 4π

Question. 6

Given the finite length input $x[n]$ and the corresponding finite length output $y[n]$ of an LTI system as shown below, the impulse response $h[n]$ of the system is

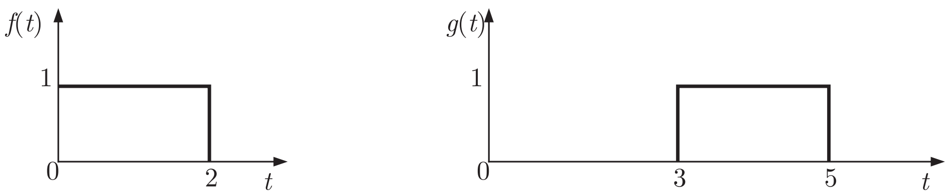


(A) $h[n] = \{\underset{\uparrow}{1}, 0, 0, 1\}$ (B) $h[n] = \{\underset{\uparrow}{1}, 0, 1\}$

(C) $h[n] = \{\underset{\uparrow}{1}, 1, 1, 1\}$ (D) $h[n] = \{\underset{\uparrow}{1}, 1, 1\}$

Common Data Questions Q. 7 & 8

Given $f(t)$ and $g(t)$ as show below



Question. 7

$g(t)$ can be expressed as

(A) $g(t) = f(2t - 3)$ (B) $g(t) = f\left(\frac{t}{2} - 3\right)$

(C) $g(t) = f\left(2t - \frac{3}{2}\right)$ (D) $g(t) = f\left(\frac{t}{2} - \frac{3}{2}\right)$

Question. 8

The Laplace transform of $g(t)$ is

(A) $\frac{1}{s}(e^{3s} - e^{5s})$ (B) $\frac{1}{s}(e^{-5s} - e^{-3s})$

(C) $\frac{e^{-3s}}{s}(1 - e^{-2s})$ (D) $\frac{1}{s}(e^{5s} - e^{3s})$

YEAR 2009 ONE MARK

Question. 9

A Linear Time Invariant system with an impulse response $h(t)$ produces output $y(t)$ when input $x(t)$ is applied. When the input $x(t-\tau)$ is applied to a system with impulse response $h(t-\tau)$, the output will be

(A) $y(\tau)$ (B) $y(2(t-\tau))$

(C) $y(t-\tau)$ (D) $y(t-2\tau)$

YEAR 2009 TWO MARKS

Question. 10

A cascade of three Linear Time Invariant systems is causal and unstable. From this, we conclude that

(A) each system in the cascade is individually causal and unstable

(B) at least on system is unstable and at least one system is causal

(C) at least one system is causal and all systems are unstable

(D) the majority are unstable and the majority are causal

Question. 11

The Fourier Series coefficients of a periodic signal $x(t)$ expressed as $x(t) = \sum_{k=-\infty}^{\infty} a_k e^{j2\pi kt/T}$ are given by $a_{-2} = 2 - j1$, $a_{-1} = 0.5 + j0.2$, $a_0 = j2$, $a_1 = 0.5 - j0.2$, $a_2 = 2 + j1$ and $a_k = 0$ for $|k| > 2$

Which of the following is true ?

(A) $x(t)$ has finite energy because only finitely many coefficients are non-zero

(B) $x(t)$ has zero average value because it is periodic

(C) The imaginary part of $x(t)$ is constant

(D) The real part of $x(t)$ is even

Question. 12

The z-transform of a signal $x[n]$ is given by $4z^{-3} + 3z^{-1} + 2 - 6z^2 + 2z^3$

It is applied to a system, with a transfer function $H(z) = 3z^{-1} - 2$

Let the output be $y[n]$. Which of the following is true ?

(A) $y[n]$ is non causal with finite support

(B) $y[n]$ is causal with infinite support

(C) $y[n] = 0; |n| > 3$

(D) $\mathrm{Re}[Y(z)]_{z=e^{j\theta}} = -\mathrm{Re}[Y(z)]_{z=e^{-j\theta}}$
$\mathrm{Im}[Y(z)]_{z=e^{j\theta}} = \mathrm{Im}[Y(z)]_{z=e^{-j\theta}}; \quad -\pi \le \theta < \pi$

YEAR 2008 ONE MARK

Question. 13

The impulse response of a causal linear time-invariant system is given as $h(t)$. Now consider the following two statements :

Statement (I): Principle of superposition holds

Statement (II): $h(t) = 0$ for $t < 0$

Which one of the following statements is correct ?

(A) Statements (I) is correct and statement (II) is wrong

(B) Statements (II) is correct and statement (I) is wrong

(C) Both Statement (I) and Statement (II) are wrong

(D) Both Statement (I) and Statement (II) are correct

Question. 14

A signal $e^{-\alpha t}\sin(\omega t)$ is the input to a real Linear Time Invariant system. Given K and ϕ are constants, the output of the system will be of the form $Ke^{-\beta t}\sin(vt+\phi)$ where

(A) β need not be equal to α but v equal to ω

(B) v need not be equal to ω but β equal to α

(C) β equal to α and v equal to ω

(D) β need not be equal to α and v need not be equal to ω

YEAR 2008 **TWO MARKS**

Question. 15

A system with $x(t)$ and output $y(t)$ is defined by the input-output relation :

$$y(t) = \int_{-\infty}^{-2t} x(t)\, d\tau$$

The system will be

(A) Casual, time-invariant and unstable

(B) Casual, time-invariant and stable

(C) non-casual, time-invariant and unstable

(D) non-casual, time-variant and unstable

Question. 16

A signal $x(t) = \text{sinc}(\alpha t)$ where α is a real constant $(\text{sinc}(x) = \frac{\sin(\pi x)}{\pi x})$ is the input to a Linear Time Invariant system whose impulse response $h(t) = \text{sinc}(\beta t)$, where β is a real constant. If min (α, β) denotes the minimum of α and β and similarly, max (α,β) denotes the maximum of α and β, and K is a constant, which one of the following statements is true about the output of the system ?

(A) It will be of the form $K\text{sinc}(\gamma t)$ where $\gamma = \min(\alpha,\beta)$

(B) It will be of the form $K\text{sinc}(\gamma t)$ where $\gamma = \max(\alpha,\beta)$

(C) It will be of the form $K\text{sinc}(\alpha t)$

(D) It can not be a sinc type of signal

Question. 17

Let $x(t)$ be a periodic signal with time period T, Let $y(t) = x(t-t_0) + x(t+t_0)$ for some t_0. The Fourier Series coefficients of $y(t)$ are denoted by b_k. If $b_k = 0$ for all odd k, then t_0 can be equal to

(A) $T/8$ (B) $T/4$

(C) $T/2$ (D) $2T$

Question. 18

$H(z)$ is a transfer function of a real system. When a signal $x[n] = (1+j)^n$ is the input to such a system, the output is zero. Further, the Region of convergence (ROC) of $(1-\frac{1}{2}z^{-1})$ H(z) is the entire Z-plane (except $z=0$). It can then be inferred that $H(z)$ can have a minimum of

(A) one pole and one zero

(B) one pole and two zeros

(C) two poles and one zero

D) two poles and two zeros

Question. 19

Given $X(z) = \dfrac{z}{(z-a)^2}$ with $|z| > a$, the residue of $X(z)z^{n-1}$ at $z = a$ for $n \geq 0$ will be

(A) a^{n-1} (B) a^n

(C) na^n (D) na^{n-1}

Question. 20

Let $x(t) = \text{rect}(t-\frac{1}{2})$ (where $rect(x) = 1$ for $-\frac{1}{2} \leq x \leq \frac{1}{2}$ and zero otherwise. If $\text{sinc}(x) = \frac{\sin(\pi x)}{\pi x}$, then the Fourier Transform of

$x(t) + x(-t)$ will be given by

(A) $\text{sinc}\left(\frac{\omega}{2\pi}\right)$

(B) $2\text{sinc}\left(\frac{\omega}{2\pi}\right)$

(C) $2\text{sinc}\left(\frac{\omega}{2\pi}\right)\cos\left(\frac{\omega}{2}\right)$

(D) $\text{sinc}\left(\frac{\omega}{2\pi}\right)\sin\left(\frac{\omega}{2}\right)$

Question. 21

Given a sequence $x[n]$, to generate the sequence $y[n] = x[3-4n]$, which one of the following procedures would be correct ?

(A) First delay $x(n)$ by 3 samples to generate $z_1[n]$, then pick every 4^{th} sample of $z_1[n]$ to generate $z_2[n]$, and than finally time reverse $z_2[n]$ to obtain $y[n]$.

(B) First advance $x[n]$ by 3 samples to generate $z_1[n]$, then pick every 4^{th} sample of $z_1[n]$ to generate $z_2[n]$, and then finally time reverse $z_2[n]$ to obtain $y[n]$

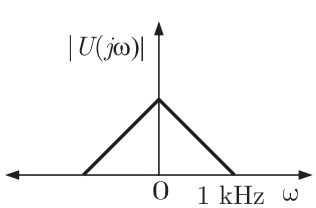
(C) First pick every fourth sample of $x[n]$ to generate $v_1[n]$, time-reverse $v_1[n]$ to obtain $v_2[n]$, and finally advance $v_2[n]$ by 3 samples to obtain $y[n]$

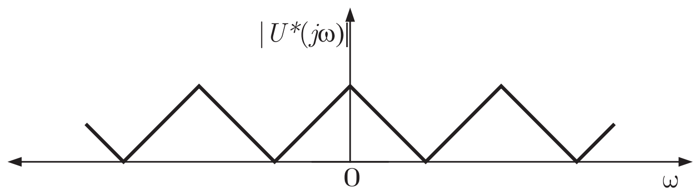
(D) First pick every fourth sample of $x[n]$ to generate $v_1[n]$, time-reverse $v_1[n]$ to obtain $v_2[n]$, and finally delay $v_2[n]$ by 3 samples to obtain $y[n]$

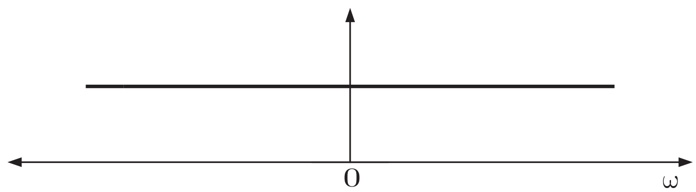
YEAR 2007 **ONE MARK**

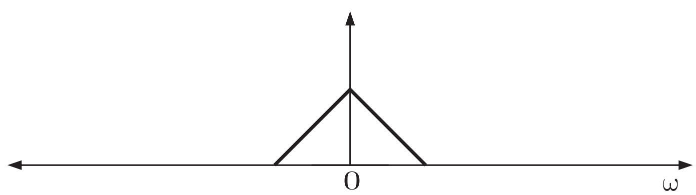
Question. 22

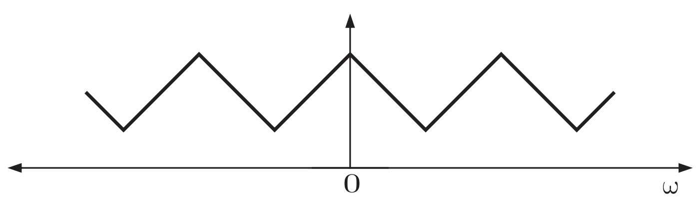
The frequency spectrum of a signal is shown in the figure. If this is ideally sampled at intervals of 1 ms, then the frequency spectrum of the sampled signal will be











Question. 23

Let a signal $a_1 \sin(\omega_1 t + \phi)$ be applied to a stable linear time variant system. Let the corresponding steady state output be represented as $a_2 F(\omega_2 t + \phi_2)$. Then which of the following statement is true?

(A) F is not necessarily a "Sine" or "Cosine" function but must be periodic with $\omega_1 = \omega_2$.

(B) F must be a "Sine" or "Cosine" function with $a_1 = a_2$

(C) F must be a "Sine" function with $\omega_1 = \omega_2$ and $\phi_1 = \phi_2$

(D) F must be a "Sine" or "Cosine" function with $\omega_1 = \omega_2$

YEAR 2007 **TWO MARKS**

Question. 24

A signal $x(t)$ is given by

$$x(t) = \begin{cases} 1, -T/4 < t \leq 3T/4 \\ -1, 3T/4 < t \leq 7T/4 \\ -x(t+T) \end{cases}$$

Which among the following gives the fundamental fourier term of $x(t)$?

(A) $\frac{4}{\pi}\cos\left(\frac{\pi t}{T} - \frac{\pi}{4}\right)$
(B) $\frac{\pi}{4}\cos\left(\frac{\pi t}{2T} + \frac{\pi}{4}\right)$
(C) $\frac{4}{\pi}\sin\left(\frac{\pi t}{T} - \frac{\pi}{4}\right)$
(D) $\frac{\pi}{4}\sin\left(\frac{\pi t}{2T} + \frac{\pi}{4}\right)$

Statement for Linked Answer Question 25 & 26 :

Question. 25

A signal is processed by a causal filter with transfer function $G(s)$

For a distortion free output signal wave form, $G(s)$ must

(A) provides zero phase shift for all frequency
(B) provides constant phase shift for all frequency
(C) provides linear phase shift that is proportional to frequency
(D) provides a phase shift that is inversely proportional to frequency

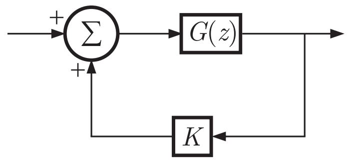
Question. 26

$G(z) = \alpha z^{-1} + \beta z^{-3}$ is a low pass digital filter with a phase characteristics same as that of the above question if

(A) $\alpha = \beta$
(B) $\alpha = -\beta$
(C) $\alpha = \beta^{(1/3)}$
(D) $\alpha = \beta^{(-1/3)}$

Question. 27

Consider the discrete-time system shown in the figure where the impulse response of $G(z)$ is $g(0) = 0, g(1) = g(2) = 1, g(3) = g(4) = \cdots = 0$



This system is stable for range of values of K

(A) $[-1, \frac{1}{2}]$ (B) $[-1, 1]$

(C) $[-\frac{1}{2}, 1]$ (D) $[-\frac{1}{2}, 2]$

Question. 28

If $u(t), r(t)$ denote the unit step and unit ramp functions respectively and $u(t) * r(t)$ their convolution, then the function $u(t+1) * r(t-2)$ is given by

(A) $\frac{1}{2}(t-1)\,u(t-1)$ (B) $\frac{1}{2}(t-1)\,u(t-2)$

(C) $\frac{1}{2}(t-1)^2 u(t-1)$ (D) None of the above

Question. 29

$X(z) = 1 - 3z^{-1}$, $Y(z) = 1 + 2z^{-2}$ are Z transforms of two signals $x[n], y[n]$ respectively. A linear time invariant system has the impulse response $h[n]$ defined by these two signals as $h[n] = x[n-1] * y[n]$ where * denotes discrete time convolution. Then the output of the system for the input $\delta[n-1]$

(A) has Z-transform $z^{-1}X(z)\,Y(z)$

(B) equals $\delta[n-2] - 3\delta[n-3] + 2\delta[n-4] - 6\delta[n-5]$

(C) has Z-transform $1 - 3z^{-1} + 2z^{-2} - 6z^{-3}$

(D) does not satisfy any of the above three

YEAR 2006 **ONE MARK**

Question. 30

The following is true

(A) A finite signal is always bounded

(B) A bounded signal always possesses finite energy

(C) A bounded signal is always zero outside the interval $[-t_0, t_0]$ for some t_0

(D) A bounded signal is always finite

Question. 31

$x(t)$ is a real valued function of a real variable with period T. Its trigonometric Fourier Series expansion contains no terms of frequency $\omega = 2\pi(2k)/T; k = 1, 2\cdots$ Also, no sine terms are present. Then $x(t)$ satisfies the equation

(A) $x(t) = - x(t - T)$

(B) $x(t) = x(T - t) = - x(- t)$

(C) $x(t) = x(T - t) = - x(t - T/2)$

(D) $x(t) = x(t - T) = x(t - T/2)$

Question. 32

A discrete real all pass system has a pole at $z = 2\angle 30^\circ$: it, therefore

(A) also has a pole at $\frac{1}{2}\angle 30^\circ$

(B) has a constant phase response over the z-plane: $\arg|H(z)| =$ constant constant

(C) is stable only if it is anti-causal

(D) has a constant phase response over the unit circle: $\arg|H(e^{i\Omega})| =$ constant

YEAR 2006 **TWO MARKS**

Question. 33

$x[n] = 0; n < -1, n > 0, x[-1] = -1, x[0] = 2$ is the input and

$y[n] = 0; n < -1, n > 2, y[-1] = -1 = y[1], y[0] = 3, y[2] = -2$ is the output of a discrete-time LTI system. The system impulse response $h[n]$ will be

(A) $h[n] = 0; n < 0, n > 2, h[0] = 1, h[1] = h[2] = -1$

(B) $h[n] = 0; n < -1, n > 1, h[-1] = 1, h[0] = h[1] = 2$

(C) $h[n] = 0; n < 0, n > 3, h[0] = -1, h[1] = 2, h[2] = 1$

(D) $h[n] = 0; n < -2, n > 1, h[-2] = h[1] = h[-1] = - h[0] = 3$

Question. 34

The discrete-time signal $x[n] \longleftrightarrow X(z) = \sum_{n=0}^{\infty} \frac{3^n}{2+n} z^{2n}$, where $\longleftrightarrow$ denotes a transform-pair relationship, is orthogonal to the signal

(A) $y_1[n] \leftrightarrow Y_1(z) = \sum_{n=0}^{\infty}\left(\frac{2}{3}\right)^n z^{-n}$

(B) $y_2[n] \leftrightarrow Y_2(z) = \sum_{n=0}^{\infty}(5^n - n)\, z^{-(2n+1)}$

(C) $y_3[n] \leftrightarrow Y_3(z) = \sum_{n=-\infty}^{\infty} 2^{-|n|} z^{-n}$

(D) $y_4[n] \leftrightarrow Y_4(z) = 2z^{-4} + 3z^{-2} + 1$

Question. 35

A continuous-time system is described by $y(t) = e^{-|x(t)|}$, where $y(t)$ is the output and $x(t)$ is the input. $y(t)$ is bounded

(A) only when $x(t)$ is bounded

(B) only when $x(t)$ is non-negative

(C) only for $t \le 0$ if $x(t)$ is bounded for $t \ge 0$

(D) even when $x(t)$ is not bounded

Question. 36

The running integration, given by $y(t) = \int_{-\infty}^{t} x(t')\, dt'$

(A) has no finite singularities in its double sided Laplace Transform $Y(s)$

(B) produces a bounded output for every causal bounded input

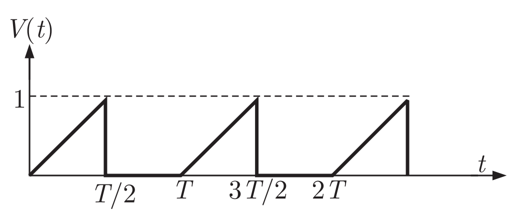
(C) produces a bounded output for every anticausal bounded input

(D) has no finite zeroes in its double sided Laplace Transform $Y(s)$

YEAR 2005 TWO MARKS

Question. 37

For the triangular wave from shown in the figure, the RMS value of the voltage is equal to



(A) $\sqrt{\frac{1}{6}}$ (B) $\sqrt{\frac{1}{3}}$

(C) $\frac{1}{3}$ (D) $\sqrt{\frac{2}{3}}$

Question. 38

The Laplace transform of a function $f(t)$ is $F(s) = \frac{5s^2 + 23s + 6}{s(s^2 + 2s + 2)}$ as $t \to \infty$, $f(t)$ approaches

(A) 3 (B) 5

(C) $\frac{17}{2}$ (D) ∞

Question. 39

The Fourier series for the function $f(x) = \sin^2 x$ is

(A) $\sin x + \sin 2x$ (B) $1 - \cos 2x$

(C) $\sin 2x + \cos 2x$ (D) $0.5 - 0.5\cos 2x$

Question. 40

If $u(t)$ is the unit step and $\delta(t)$ is the unit impulse function, the inverse z-transform of $F(z) = \frac{1}{z+1}$ for $k > 0$ is

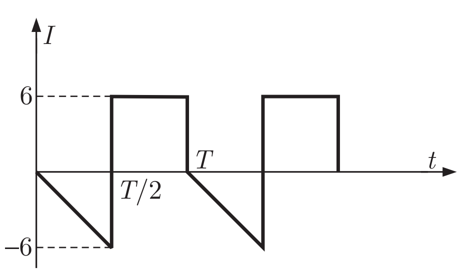
(A) $(-1)^k \delta(k)$ (B) $\delta(k) - (-1)^k$

(C) $(-1)^k u(k)$ (D) $u(k) - (-1)^k$

YEAR 2004 TWO MARKS

Question. 41

The rms value of the periodic waveform given in figure is



(A) $2\sqrt{6}$ A (B) $6\sqrt{2}$ A

(C) $\sqrt{4/3}$ A (D) 1.5 A

Question. 42

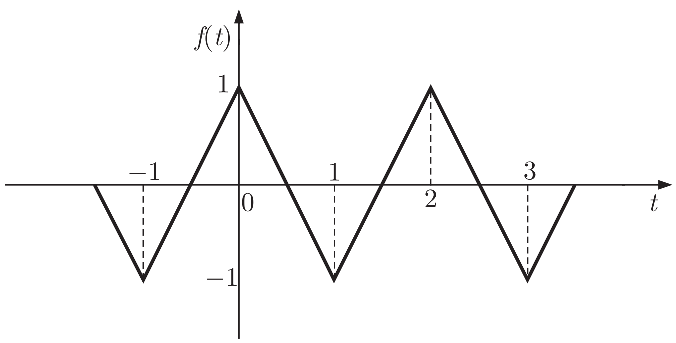
The rms value of the resultant current in a wire which carries a dc current of 10 A and a sinusoidal alternating current of peak value 20 is

(A) 14.1 A
(B) 17.3 A
(C) 22.4 A
(D) 30.0 A

YEAR 2002 ONE MARK

Question. 43

Fourier Series for the waveform, $f(t)$ shown in Figure is



(A) $\frac{8}{\pi^2}\left[\sin(\pi t) + \frac{1}{9}\sin(3\pi t) + \frac{1}{25}\sin(5\pi t) + ...\right]$

(B) $\frac{8}{\pi^2}\left[\sin(\pi t) - \frac{1}{9}\cos(3\pi t) + \frac{1}{25}\sin(5\pi t) + ...\right]$

(C) $\frac{8}{\pi^2}\left[\cos(\pi t) + \frac{1}{9}\cos(3\pi t) + \frac{1}{25}\cos(5\pi t) + ...\right]$

(D) $\frac{8}{\pi^2}\left[\cos(\pi t) - \frac{1}{9}\sin(3\pi t) + \frac{1}{25}\sin(5\pi t) + ...\right]$

Question. 44

Let $s(t)$ be the step response of a linear system with zero intial conditions; then the response of this system to an an input $u(t)$ is

(A) $\int_0^t s(t-\tau)\, u(\tau)\, d\tau$
(B) $\frac{d}{dt}\left[\int_0^t s(t-\tau)\, u(\tau)\, d\tau\right]$
(C) $\int_0^t s(t-\tau)\left[\int_0^t u(\tau_1)\, d\tau_1\right] d\tau$
(D) $\int_0^1 [s(t-\tau)]^2\, u(\tau)\, d\tau$

Question. 45

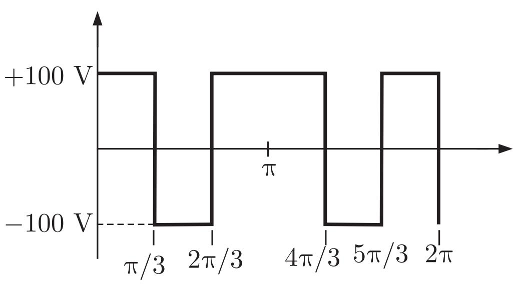
Let $Y(s)$ be the Laplace transformation of the function $y(t)$, then the final value of the function is

(A) $\lim_{s \to 0} Y(s)$ (B) $\lim_{s \to \infty} Y(s)$

(C) $\lim_{s \to 0} sY(s)$ (D) $\lim_{s \to \infty} sY(s)$

Question. 46

What is the rms value of the voltage waveform shown in Figure ?



(A) $(200/\pi)$ V (B) $(100/\pi)$ V

(C) 200 V (D) 100 V

YEAR 2001 **ONE MARK**

Question. 47

Given the relationship between the input $u(t)$ and the output $y(t)$ to be

$$y(t) = \int_0^t (2 + t - \tau)\, e^{-3(t-\tau)} u(\tau)\, d\tau,$$

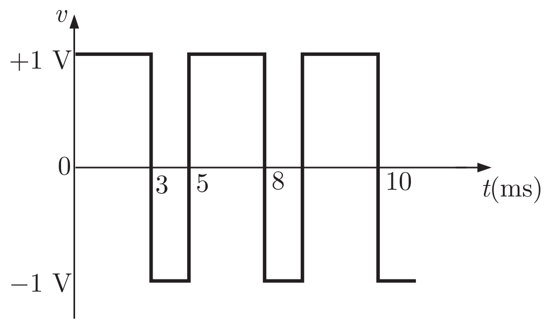
The transfer function $Y(s)/U(s)$ is

(A) $\frac{2e^{-2s}}{s+3}$ (B) $\frac{s+2}{(s+3)^2}$

(C) $\frac{2s+5}{s+3}$ (D) $\frac{2s+7}{(s+3)^2}$

Common data Questions Q. 48-49

Consider the voltage waveform v as shown in figure



Question. 48

The DC component of v is

(A) 0.4 (B) 0.2

(C) 0.8 (D) 0.1

Question. 49

The amplitude of fundamental component of v is

(A) 1.20 V (B) 2.40 V

(C) 2 V (D) 1 V

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