Gate Problems on Signals and Systems

***Abstract*—These problems have been selected from GATE question papers and can be used for conducting tutorials in courses related to Signal Processing.**

1. The trigonometric Fourier series of an even function of time does not have the

(A) dc term
(B) cosine terms
(C) sine terms
(D) odd hormonic terms

2. The Fourier transform of a real valued time signal

(A) odd symmetry
(B) even symmetry
(C) conjugate symmetry
(D) no symmetry

3. The function $f(t)$ has the Fourier transform $g(w)$. The Fourier Transform

(A) $\frac{1}{2\pi}f(w)$
(B) $\frac{1}{2\pi}f(-w)$
(C) $2\pi f(-w)$
(D) None of the above

4. The Laplace Transform of $e^{\alpha t}cos\alpha t u(t)$

(A) $\frac{(s-\alpha)}{(s-\alpha)^2+\alpha^2}$
(B) $\frac{(s+\alpha)}{(s-\alpha)^2+\alpha^2}$
(C) $\frac{1}{(s-\alpha)^2}$
(D) None of the above

5. A deterministic signal has the power spectrum given in the figure is, The minimum sampling rate needed to completely represent this signal is

(A) 1 kHz
(B) 2 kHz
(C) 3 kHz
(D) None of the above

6. If the Fourier Transform of deterministic signal $g(t)$ is $G(f)$,then
1. The fourier Transform of $g(t-2)$ is.
(a) $G(f)e^{-j(4\pi f)}$
2. The fourier Transform of $g(\frac{t}{2})$ is.
(b) $G(2f)$ (c) $2G(2f)$ (d) $G(f-2)$

7. The transfer function of a system is given by $H(s) = \frac{1}{s^2(s-2)}$.The impulse response of the system is :($*$ denotes convolution,and $U(t)$ is unit step function)

(A) $(t^2 * e^{-2t})U(t)$
(B) $(t * e^{2t})U(t)$
(C) $(te^{-2}t)U(t)$
(D) $(te^{-2t})U(t)$

8. Let $\delta(t)$ denote the delta function.The value of the integral $\int_{-\infty}^{+\infty}\delta(t)cos(\frac{3t}{2})dt$ is

(A) 1 (B) -1 (C) 0 (D) $\frac{\pi}{2}$

9. A band limited signal is sampled at the Nyquist rate.The signal can be recovered by passing the samples through

(A) An RC filter
(B) an envelope detector

(C) a PLL

(D) an ideal low-pass filter with appripriate bandwidth

10. The impulse response functions of four linear systems S_1,S_2,S_3 and S_4 are given respectively by
$h_1(t) = 1$, $h_2(t) = u(t)$,$h_3(t) = \frac{u(t)}{t+1}$, $h_4(t) = e^{-3t}u(t)$.Where $u(t)$ is the unit step function. Which of these systems is time invariant,causal and Stable ?

(A) S_1 (B) S_2 (C) S_3 (D) S_4

11. The open-loop DC gain of a unity negative feedback system with close-loop transfer function $\frac{s+4}{s^2+7s+13}$ is

(A) $\frac{4}{13}$ (B) $\frac{4}{13}$ (C) 4 (D) 13

12. The Nyquist sampling interval,for the signal $Sinc(700t) + Sinc(500t)$ is (in seconds)

(A) $\frac{1}{350}$ (B) $\frac{\pi}{350}$ (C) $\frac{1}{700}$ (D) $\frac{\pi}{175}$

13. Which of the following cannot be the Fourier series of a periodic signal ?

(A) $x(t) = 2cost + 3cos3t$

(B) $x(t) = 2cos\pi t + 7cost$

(C) $x(t) = cost + 0.5$

(D) $x(t) = 2cos1.5\pi t + sin3.5\pi t$

14. The fourier transform $F(e^{-1}u(t))$ is equal to $\frac{1}{a+j2\pi f}$.Therefore,$F\{\frac{1}{a+j2\pi t}\}$

(A) $e^f u(f)$ (C) $e^f u(-f)$

(B) $e^{-f}u(f)$ (D) $e^{-f}u(-f)$

15. A linear phase channel with phase delay T_p and group delay T_g must have

(A) T_p=T_g=Constant

(B) $T_p \propto$ f and $T_g \propto$ f

(C) T_p=constant and $T_g \propto$ f

(D) $T_p \propto$ f and T_g =constant

16. A 1 MHz sinusoidal carrier is amplitude modulated by a symmetrical square wave of period 100 μsec.Which of the following frequencies will NOT be present in the modulated signal ?

(A) $990KHz$ (C) $1020KHz$

(B) $1010KHz$ (D) $1030KHz$

17. Consider a sampled signal $y(t)=5 \times 10^{-6}x(t)\sum_{n=-\infty}^{+\infty}\delta(t-nT_s)$ is

(A) $5 \times 10^{-6}cos(8\pi \times 10^3 t)$

(B) $5 \times 10^{-5}cos(8\pi \times 10^3 t)$

(C) $5 \times 10^{-1}cos(8\pi \times 10^3 t)$

(D) $10cos(8\pi \times 10^3 t)$

18. The Laplace transform of a continuous-time signal $x(t)$ is $X(s) = \frac{5-s}{s^2-s-2}$.If the Fourier transform of this signall exists,then $x(t)$ is

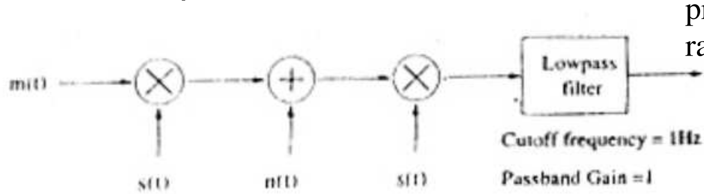
(A) $e^{2t}u(t) - 2e^{-t}u(t)$

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

(C) $-e^{2t}u(-t) - 2e^{-t}u(t)$

(D) $e^{2t}u(-t) - 2e^{-t}u(t)$

19. In below figure, $m(t) = \dfrac{2sin2\pi t}{t}$,$s(t) = cos200\pi t$ and $n(t) = \dfrac{sin199\pi t}{t}$.The output is



(A) $\dfrac{sin2\pi t}{t}$

(B) $\dfrac{sin2\pi t}{t} + \dfrac{sin2\pi t}{t}cos(3\pi t)$

(C) $\dfrac{sin2\pi t}{t} + \dfrac{sin0.5\pi t}{t}cos(1.5\pi t)$

(D) $\dfrac{sin2\pi t}{t} + \dfrac{sin\pi t}{t}cos(0.75\pi t)$

20. A signal $x(t) = 100cos(24\pi \times 10^3 t)$ is ideally sampled with a sampling period of 50μsec and then passed through an ideal low-pass filter with cutoff frequency of 15 KHz. Which of the following frequencies is/are present at the filter output ?

(A) 12 KHz only (C) 12 KHz and 9 KHz

(B) 8 KHz only (D) 12 KHz and 8 KHz

21. The Fourier series expansion of a real periodic signal with fundamental frequency f_0 is given by $g_p(t) = \sum_{n=-\infty}^{+\infty} c_n e^{j2\pi n f_0 t}$ is is given that $C_3 = 3 + j5$.Then C_{-3} is

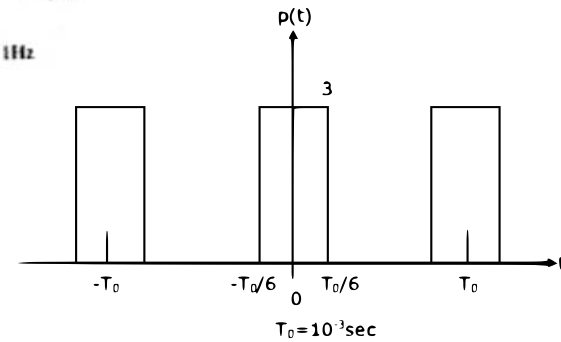
(A) $5 + j3$ (C) $-5 - j3$

(B) $-3 - j5$ (D) $3 - j5$

22. Let $x(t)$ be the input to a linear,time-invariant system. The required output is $4x(t-2)$.The transfer function of the system should be

(A) $4e^{j4\pi f}$ (B) $2e^{-j8\pi f}$ (C) $4e^{-j4\pi f}$ (D) $2e^{j8\pi f}$

23. Let $x(t) = 2cos(800\pi t) + cos(1400\pi t)$,$x(t)$ sampled with the rectangular pulse train shown in figure. The only spectral components (in kHz) present in the sampled signal in the frequency range 2.5 kHz to 3.5 kHz are



(A) 2.7, 3.4 (C) 2.6, 2.7, 3.3, 3.4, 3.6

(B) 3.3, 3.6 (D) 2.7, 3.3

Data for ***Q.24-25*** are given below. Solve the problems and choose the correct answers.
The system under consideration is an RC low-pass filter (RC-LPF) with R=1.0KΩ and C=1.0 μF

24. Let $H(f)$ denote the frequency response of the RC-LPF.Let f_1 be the highest frequency such that $0 \le |f| \le f_1, \dfrac{|H(f_1|}{H(0)} \ge 0.95$.Then f_1 (in HZ) is

(A) 327.8 (B) 163.9 (C) 52.2 (D) 104.4

25. Let $t_g(f)$ be the group dealy function of the given RC-LPF and $f_2 = 100Hz$.Then $t_g(f_2)$ in ms,is

(A) 0.717 (B) 7.17 (C) 71.7 (D) 4.505

26. The Fourier transform of a conjugate symmetric function is always

(A) real

(B) conjugate anti-symmetric

(C) real

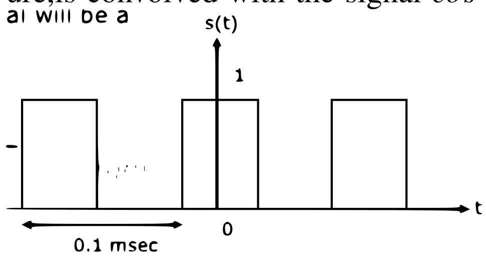
(D) conjugate symmetric

27. A 1 kHz sinusoidal signal is ideally sampled at 1500 samples/sec and the sampled signal is passed through an ideal low-pass filter with cut-off freuency 800 Hz.The output signal has the frequency ?

(A) 0 Hz (C) 0.5 kHz

(B) 0.75 kHz (D) 0.25 kHz

28. A rectangular pulse train s(t) as shown in figure,is convolved with the signal $cos^2(4\pi \times 10^3)t$.



(A) DC (C) 8 kHz sinusoid

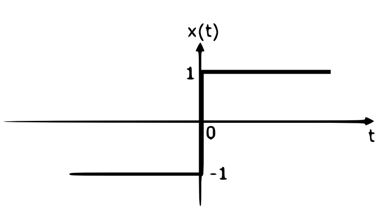
(B) 12 kHz sinusoid (D) 14 kHz sinusoid

29. A causal system having the transfer function $H(s) = \dfrac{1}{s+2}$ is excited with $10u(t)$.The time at which the ouput reaches 99% of its steady state value is

(A) 2.7 sec (C) 2.4 sec

(B) 2.5 sec (D) 2.1 sec

30. The function $x(t)$ is shown in figure. Even and odd parts of a unit-step function $u(t)$ are respectively.



(A) $\frac{1}{2}, \frac{1}{2}x(t)$ (C) $\frac{1}{2}, -\frac{1}{2}x(t)$

(B) $-\frac{1}{2}, \frac{1}{2}x(t)$ (D) $-\frac{1}{2}, -\frac{1}{2}x(t)$

31. The output $y(t)$ of a linear time invariant system is related to its input $x(t)$ by the following equation. $y(t) = 0.5x(t-t_d+T)+x(t-t_d)+0.5x(t-t_d-T)$. The filter transfer function $H(w)$ of such a system is given by

(A) $(1 + coswT)e^{-jwt_d}$

(B) $(1 + 0.5coswT)e^{-jwt_d}$

(C) $(1 + coswT)e^{jwt_d}$

(D) $(1 - 0.5coswT)e^{-jwt_d}$

32. For a signal $x(t)$ the Fourier transform is $X(f)$.Then the inverse Fourier transform of $X(3f + 2)$ is given by

(A) $\frac{1}{2}x(\frac{1}{2})e^{j3\pi t}$ (C) $\frac{1}{3}x(\frac{1}{3})e^{\frac{-j4\pi t}{3}}$

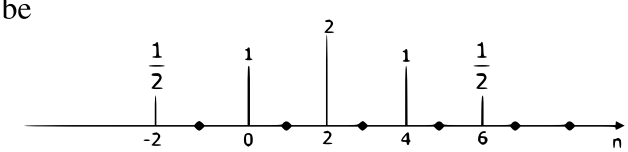
(B) $3x(3t)e^{-j4\pi t}$ (D) $x(3t + 2)$

33. ***(A)*** The Sequence

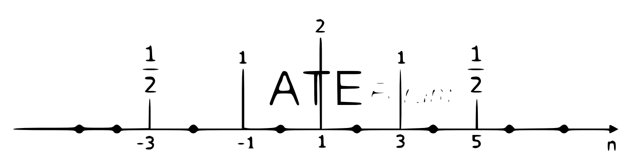
$$y(n) = \begin{cases} x(\frac{n}{2} - 1), & \text{for n even} \\ 0, & \text{odd} \ . \end{cases}$$

will be

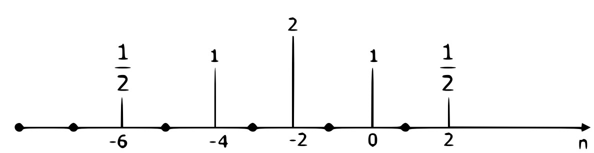
(a)



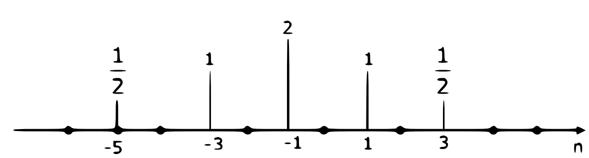
(b)



(c)



(d)



(B) The Fourier transform of $y(2n)$ will be

(A) $e^{-2j\omega}[cos4\omega + 2cos2\omega + 2]$

(B) $[cos2\omega + 2cos\omega + 2]$

(C) $e^{-j\omega}[cos2\omega + 2cos\omega + 2]$

(D) $e^{j\omega}[cos2\omega + 2cos\omega + 2]$

34. Let $x(t) \leftrightarrow X(j\omega)$ be Fourier Transform pair.The Fourier Transform of the signal $x(5t - 3)$ in terms of $X(j\omega)$ is given as

(A) $\frac{1}{5}e^{\frac{-j3\omega}{5}} X(\frac{j\omega}{5})$

(B) $\frac{1}{5}e^{\frac{j3\omega}{5}} X(\frac{j\omega}{5})$

(C) $\frac{1}{5}e^{-j3\omega} X(\frac{j\omega}{5})$

(D) $\frac{1}{5}e^{j3\omega} X(\frac{j\omega}{5})$

35. The dirac delta function $\delta(t)$ is defined as

(A)
$$\delta(t) = \begin{cases} 1, & \text{t=0} \\ 0, & \text{otherwise} \end{cases}.$$

(B)
$$\delta(t) = \begin{cases} \infty, & \text{t=0} \\ 0, & \text{otherwise} \end{cases}.$$

(C)
$$\delta(t) = \begin{cases} 1, & \text{t=0} \\ 0, & \text{otherwise} \end{cases}.$$

and $\int_{-\infty}^{+\infty} \delta(t)dt$

(D)
$$\delta(t) = \begin{cases} \infty, & \text{t=0} \\ 0, & \text{otherwise} \end{cases}.$$

and $\int_{-\infty}^{+\infty} \delta(t)dt$

36. A signal $m(t)$ with bandwidth 500 Hz is first multiplied by a signal $g(t)$ where $g(t) = \sum_{k=-\infty}^{\infty}(-1)^k\delta(t - 0.5 \times 10^{-4}k)$
The resulting signal is then passed through an ideal lowpass filter with bandwidth 1 kHz.The output of the lowpass filter would be:

(A) $\delta(t)$

(B) $m(t)$

(C) 0

(D) $m(t)\delta(t)$

37. The minimum sampling frequency (in samples/sec) required to reconstruct the following signal from its samples withour distorion.
$x(t) = 5(\frac{sin2\pi1000t}{\pi t})^3 + 7(\frac{sin2\pi1000t}{\pi t})^2$

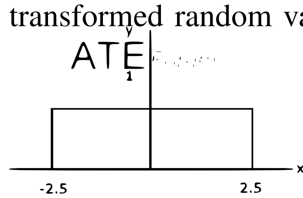
(A) 2×10^3

(B) 4×10^3

(C) 6×10^3

(D) 8×10^3

38. A uniformly distributed random variable x with probability density function $f_X(x) = \frac{1}{10}(u(x+5) - u(x - 5))$
Where $u(.)$ is the unit step function is passed through a transformation given in the figure below.The probability density function of the transformed random variable Y would be



(A) $f_Y(y) = \frac{1}{5}(u(y + 2.5) - u(y - 2.5))$

(B) $f_Y(y) = \frac{1}{2}(\delta(y) - \delta(y - 1))$

(C) $f_Y(y) = \frac{1}{4}(\delta(y + 2.5) - \delta(y - 2.5)) + \frac{1}{2}\delta(y)$

(D) $f_Y(y) = \frac{1}{4}(\delta(y + 2.5) - \delta(y - 2.5)) + \frac{1}{10}(u(y + 2.5)) - u(y - 2.5)$

39. The 3-dB bandwidth of teh low-pass signal $e^{-t}u(t)$,where $u(t)$ is the unit step function, is given by

(A) $\frac{1}{2\pi}$ Hz

(B) $\frac{1}{2\pi}\sqrt{\sqrt{2} - 1}$ Hz

(C) ∞

(D) 1 Hz

40. The unit-step response of a system starting from rest is given by
$c(t) = 1 - e^{-2t} fort \geq 0$
The transfer function of the system is:

(A) $\frac{1}{1+2s}$ (C) $\frac{1}{2+s}$

(B) $\frac{2}{2+s}$ (D) $\frac{2s}{1+2s}$

41. A Hilbert transformer is a

(A) non-linear system

(B) non-causal system

(C) time-varying system

(D) low-pass system

42. The frequency response of linear,time-invariant system is given by $H(f) = \frac{5}{1 + j10\pi f}$. The step response of the system is

(A) $5(1 - e^{-5t})u(t)$

(B) $5(1 - e^{\frac{-t}{5}})u(t)$

(C) $\frac{1}{5}(1 - e^{-5t})u(t)$

(D) $\frac{1}{5}(1 - e^{\frac{-t}{5}})u(t)$

43. The input and output of a continous time systems are respectively denoted by $x(t)$ and $y(t)$.Which of the following descriptions corresponds to a causal system?

(A) $y(t) = x(t-2) + x(t+4)$

(B) $y(t) = (t-4)x(t+1)$

(C) $y(t) = (t+4)x(t-1)$

(D) $y(t) = (t+5)x(t+5)$

44. The impulse response $h(t)$ of a linear time-invariant continuous time system is described by $h(t) = e^{\alpha t}u(t) + e^{\beta t}u(-t)$,where $u(t)$ denotes the unit step function, and α and β are real constants.This system is stable if

(A) α is positive and β is positive

(B) α is negative and β is negative

(C) α is positive and β is negative

(D) α is negative and β is positive

45. A linear,time-invariant, causal continuous time system has a rational transfer function with simple poles at s=-2 and s=-4 , and one simple zero at s=-1. A unit step $u(t)$ is applied at the input of the system. At steady state, the output has constant value of 1. The impulse response of this system is

(A) $[e^{-2t} + e^{-4t}]u(t)$

(B) $[-4e^{-2t} + 12e^{-4t} - e^{-t}]u(t)$

(C) $[-4e^{-2t} + 12e^{-4t}]u(t)$

(D) $[-0.5e^{-2t} + 1.5e^{-4t}]u(t)$

46. The signal x(t) is described by

$$x(t) = \begin{cases} 1, & \text{for } -1 \leq t \leq 1 \\ 0, & \text{otherwise} \end{cases} .$$

(A) $\pi, 2\pi$ (C) $0, \pi$

(B) $0.5\pi, 1.5\pi$ (D) $2\pi, 2.5\pi$

47. A function is given by $f(t) = sin^2 t + cos2t$. Which of the following is true ?

(A) f has frequnecy components at 0 and $\frac{1}{2\pi}$ Hz

(B) f has frequnecy components at 0 and $\frac{1}{\pi}$ Hz

(C) f has frequnecy components at $\frac{1}{2\pi}$ and $\frac{1}{\pi}$ Hz

(D) f has frequnecy components at $0, \frac{1}{2\pi}$ and $\frac{1}{2\pi}$ Hz

48. The Fourier series of a real periodic function has only

(P) Cosine terms if it is even

(P) Sine terms if it is even

(P) Cosine terms if it is odd

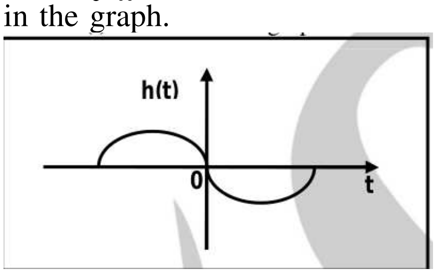
(P) Sine terms if it is odd.

Which of the above statements are correct ?

(A) P AND S (C) Q AND S

(B) P AND R (D) Q AND R

49. Consider a system whose input x and output y are related by the equation.
$y(t) = \int_{-\infty}^{+\infty} x(t-\tau)h(2\tau)d\tau$ Where h(t) is shown in the graph.



Which of the following four properties are possessed by the system ?
BIBO:Bounded Input gives Bounded Ouput
Causal:The system is Causal.
LP:The system is Lowpass.
LTI:The system is Linear and Time-Invariant.

(A) Causal, LP (C) BIBO, Causal, LTI

(B) BIBO, LTI (D) LP,LTI

50. An LTI system having transfer function $\frac{s^2+1}{s^2+2s+1}$ and input $x(t) = sinx(t)$ is in steady state.The output is sampled at a rate of ω_w rad/s to obtain the final output $\{y(k)\}$. Which of the following is true ?

(A) y(x) is zero for all sampling frequencies ω_s

(B) y(x) is nonzero for all sampling frequencies ω_s

(C) y(x) is nonzero for all sampling frequencies $\omega_s > 2$, but zero for all $\omega_s < 2$

(D) y(x) is zero for all sampling frequencies $\omega_s > 2$, but nonzero for all $\omega_s < 2$

51. The unit step response of an under-damped second order system has steady state value of -2. Which one of the following transfer functions has these properties ?

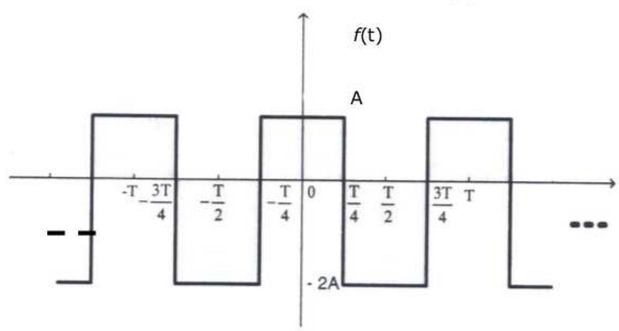
(A) $\frac{-2.24}{s^2 + 2.59s + 1.12}$

(B) $\frac{-3.82}{s^2 + 1.91s + 1.91}$

(C) $\frac{-2.24}{s^2 - 2.59s + 1.12}$

(D) $\frac{-2.24}{s^2 + 2.59s + 1.12}$

52. The trigonometric Fourier series for the waveform $f(t)$ shown below contains



(A) only cosine terms and zero value for the dc component

(B) only cosine terms and a positive value for the dc component

(C) only cosine terms and a negative value for the dc component

(D) only sine terms and a negative for the dc component

53. A system with transfer function $\frac{Y(s)}{X(s)} = \frac{s}{s+p}$ has an output $y(t) = cos(2t-\frac{\pi}{3}$ for the input signal $x(t) = pcos(2t - \frac{\pi}{2}$.Then, the system parameter 'p' is

(A) $\sqrt{3}$

(B) $\frac{2}{\sqrt{3}}$

(C) 1

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

54. A continous time LTI system is described by $\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3y(t) = 2\frac{dx(t)}{dt} + 4x(t)$

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

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

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

(D) $(e^{t} + e^{3t})u(t)$

55. The Nyquist sampling rate for the signal $s(t) = \frac{sin(500\pi t)}{\pi t} \times \frac{sin(700\pi t)}{\pi t}$ is given by

(A) 400 Hz (C) 1200 Hz

(B) 600 Hz (D) 1400 Hz

56. If the unit step response of a network is $1 - e^{-\alpha t}$, then its unit impulse response

(A) $\alpha e^{-\alpha t}$

(B) $\alpha^{-1}e^{-\alpha t}$

(C) $(1 - \alpha^{-1})e^{-\alpha t}$

(D) $(1 - \alpha)e^{-\alpha t}$

57. The trigonometric Fourier series of an even function does not have the

(A) dc term

(B) cosine terms

(C) sine terms

(D) odd harmonic terms

58. An input $x(t) = e^{-2t}u(t) + \delta(t - 6)$ is applied to an LTI system with impulse response $h(t) = u(t)$.The output is

(A) $[1 - e^{-2t}]u(t) + u(t + 6)$

(B) $[1 - e^{-2t}]u(t) + u(t - 6)$

(C) $0.5[1 - e^{-2t}]u(t) + u(t + 6)$

(D) $0.5[1 - e^{-2t}]u(t) + u(t - 6)$

59. The systems with impulse responses $h_1(t)$ and $h_2(t)$ are connected in cascade. Then the overall impulse response of the cascaded system is given by

(A) product of $h_1(t)$ and $h_2(t)$

(B) sum of $h_1(t)$ and $h_2(t)$

(C) convolution of $h_1(t)$ and $h_2(t)$

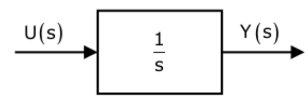
(D) Substraction of $h_2(t)$ and $h_1(t)$

60. A band-limited signal with a maximum frequency of 5 kHz is to be sampled. According to the sampling theorem, the sampling frequency which is not valid is

(A) 5 kHz (C) 15 kHz

(B) 12 kHz (D) 20 kHz

61. Assuming zero initial condition, the response $y(t)$ of the system given below to a unit step input $u(t)$ is



(A) $u(t)$

(B) $tu(t)$

(C) $\frac{t^2}{2}u(t)$

(D) $e^{-t}u(t)$

62. A system is described by the differential equation $\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 6y(t) = x(t)$. Let x(t) be a rectangular pulse given by

$$x(t) = \begin{cases} 1, & 0 < t < 2 \\ 0, & \text{otherwise} \end{cases} .$$

Assuming that $y(0) = 0$ and $\frac{dy}{dt} = 0$ at t=0, the Laplace transform of $y(t)$ is

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

(B) $\frac{1-e^{-2s}}{s(s+2)(s+3)}$

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

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

63. The impulse response of a system is $h(t) = tu(t)$.For an input $u(t-1)$,the output is

(A) $\frac{t^2}{2}u(t)$

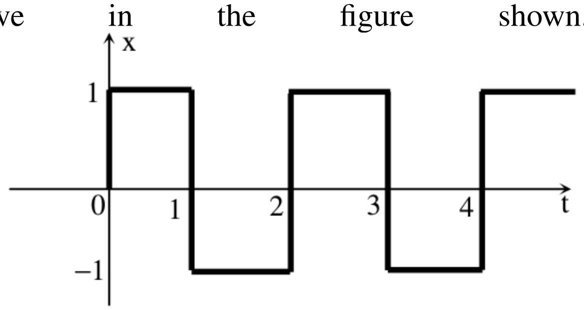
(B) $\frac{t\times(t-1)}{2}u(t-1)$

(C) $\frac{(t-1)^2}{2}u(t-1)$

(D) $\frac{t^2-1}{2}u(t-1)$

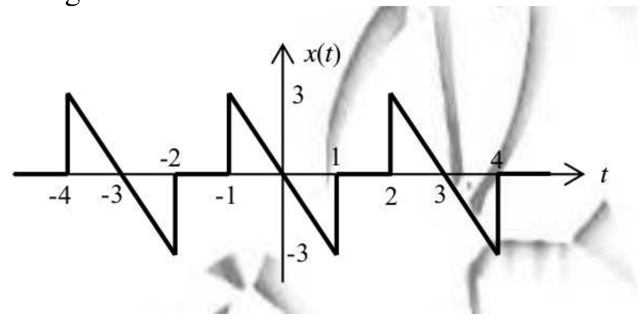
64. The value of the integral $\int_{-\infty}^{+\infty} sinc^2(5t)dt$ is _____

65. Consider the periodic square wave in the figure shown.



The ratio of the power in the 7^{th} harmonic to the power in the 5^{th} harmonic for this waveform is closest in value to __________

66. The waveform of a periodic signal $x(t)$ is shown in the figure.



A signal $g(t)$ is defined by $g(t) = x(\frac{t-1}{2})$. The average power of $g(t)$ is __________

67. Consider the signal $s(t) = m(t)cos(2\pi f_c t) + \hat{m}(t)sin(2\pi f_c t)$ where $\hat{m}(t)$ denotes the Hilbert transform of $m(t)$ and the bandwidth of $m(t)$ is very small compared to f_c.The signal $s(t)$ is a

(A) high-pass signal

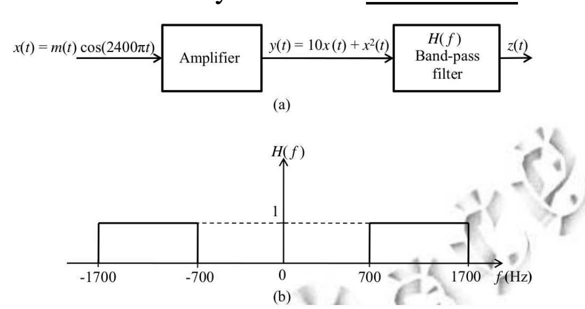
(B) low-pass signal

(C) band-pass signal

(D) double sideband suppressed carrier signal

68. A continuous-time sinusoid of frequency 33 Hz is multiplied with a periodic Dirac impulse train of frequency 46 Hz. The resulting signal is passed through an ideal analog low-pass filter with a cutoff frequency of 23 Hz. The fundamental frequency (in Hz) of the output is __________

69. In the system shown in Figure(a), $m(t)$ is a low-pass signal with bandwidth W Hz. The frequency response of the band-pass filter $H(f)$ is shown in Figure(b). If it is described that the output signal $z(t) = 10x(t)$, the maximum value of W (in Hz) should be strictly less than __________



Data for ***Questions*** given below.

The impulse response $h(t)$ of a linear time invariant continuous time system is given by $h(t) = e^{-2t}u(t)$, where $u(t)$ denotes the unit step function.

70. The frequency response $H(\omega)$ of this system in terms of angular frequency ω is give by $H(\omega)$

(A) $\frac{1}{1 + j2\omega}$ (C) $\frac{1}{2 + j\omega}$

(B) $\frac{sin(\omega)}{\omega}$ (D) $\frac{j\omega}{2 + j\omega}$

71. The output of this system to the sinusoidal input $x(t) = 2cos(2t)\ \forall t$, is

(A) 0

(B) $2^{-0.25}cos(2t - 0.125\pi)$

(C) $2^{-0.5}cos(2t - 0.125\pi)$.

(D) $2^{-0.5}cos(2t - 0.25\pi)$

72. A system described by a linear,constant coefficient, ordinary, first order differential equation has an exact solution given by $y(t)$ for $t > 0$,when the forcing function is $x(t)$ and the initial condistion is $y(0)$.If one wishes to modify the system so that the solution becomes $-2y(t)$ for $t > 0$, we need to

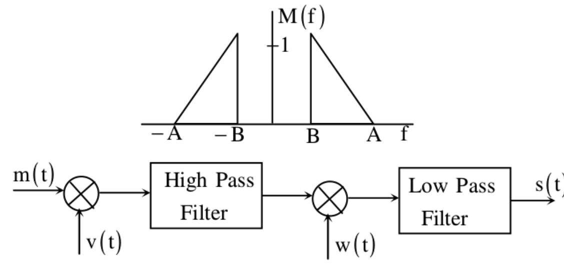
(A) change the initial condition to $-y(0)$ and the forcing function to $2x(t)$

(B) change the initial condition to $2y(0)$ and the forcing function to $-x(t)$

(C) change the initial condition to $j\sqrt{2y(0)}$ and the forcing function to $j\sqrt{x(t)}$

(D) change the initial condition to $-2y(0)$ and the forcing function to $-2x(t)$

73. In the figure,$M(f)$ is the Fourier transform of the message signal,$m(t)$ where A=100 Hz and B=40 Hz. Given $v(t) = cos(2\pi f_c t)$ and $w(t) = cos(2\pi(f_c + A))$, where $f_c > A$ The cutoff frequencies of the both filters are __________ f_c



74. The result of the convolution $x(-t) * \delta(-t - t_0)$ is

(A) $x(t + t_0)$ (C) $x(-t + t_0)$

(B) $x(t - t_0)$ (D) $x(-t - t_0)$