

GUJARAT TECHNOLOGICAL UNIVERSITY

BE-5 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

Subject Name & Code: Signals and Systems (3150912)

Unit 1: Introduction to Signals and Systems

Repeated Questions:

1. Explain the classification of signals.
 - Appeared in: S25 (Q1b, 04 marks), S24 (Q1b, 04 marks)
 2. Explain Energy and Power signals.
 - Appeared in: S25 (Q1a, 03 marks), S23 (Q1b, 04 marks), S22 (Q1b, 04 marks), W24 (Q2a, 03 marks)
 3. Explain Periodic and Non-periodic signals.
 - Appeared in: S24 (Q1a, 03 marks)
 4. Explain Odd and Even signals with diagrams/examples.
 - Appeared in: S25 (Q2c, 07 marks), S22 (Q1a, 03 marks), W22 (Q1c, 07 marks), W23 (Q2a, 03 marks)
 5. Define: Energy signal, Causal System, Analog signal, Periodic signal.
 - Appeared in: S22 (Q1b, 04 marks)
 6. Sketch signals: $u(-t)$, $-4r(t)$, $u(t+4)$, $4\cos(\omega t + \pi/2)$.
 - Appeared in: S24 (Q1c, 07 marks)
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Other Important Questions:

7. Explain the test signals.
 - Appeared in: W22 (Q1a, 03 marks)
8. Sketch signal $x(t) = u(t+2) - u(t-2) + u(t+1) - u(t-1)$.
 - Appeared in: W22 (Q1b, 04 marks), W25 (Q2c, 07 marks)
9. Explain methods of representation of signals.
 - Appeared in: S25 (Q2a, 03 marks), W22 (Q2a, 03 marks)
10. If signal $\cos(13\pi t) + 2\sin(4\pi t)$ is periodic or not? If periodic, find fundamental period.
 - Appeared in: S25 (Q2b, 04 marks), S24 (Q2b, 04 marks)
11. If signal $\cos(10t) + \sin(20t)$ is periodic or not? If periodic, find fundamental period.
 - Appeared in: W22 (Q2b, 04 marks)
12. Define a periodic continuous-time and discrete-time signal.
 - Appeared in: W24 (Q1a, 03 marks)
13. Give examples of continuous-time and discrete-time causal systems.
 - Appeared in: W24 (Q1b, 04 marks)
14. Define (i) Periodicity of a signal, (ii) Non-causal signals, (iii) Even signal with example.
 - Appeared in: W23 (Q2a, 03 marks)
15. Find whether given signals are periodic or not. If yes, give fundamental period:
 - (i) $x(t) = 3\sin(200\pi t) + 4\cos(100t)$
 - (ii) $x(n) = e^{j(\pi/2)n}$
 - Appeared in: W25 (Q1a, 03 marks)
16. Check whether $x(t) = 2\cos(100\pi t) + 5\sin(50t)$ is periodic or not.
 - Appeared in: W25 (Q1b, 03 marks)
17. Determine energy and power of signal $x(t) = u(t)$.
 - Appeared in: S22 (Q4a, 03 marks), W25 (Q2a, 03 marks)
18. Explain with example: Linearity, Homogeneity, Shift invariance.
 - Appeared in: S23 (Q1a, 03 marks)
19. Draw and explain discrete type of test signals.

- Appeared in: S24 (Q2a, 03 marks)
- 20. **State whether system is linear and time-invariant: $y(n) = u[n]^2$**
 - Appeared in: W24 (Q1c(i), 07 marks)
- 21. **State whether system is causal, stable, memoryless: $y[n] = n u[n]$**
 - Appeared in: W24 (Q1c(ii), 07 marks)
- 22. **Classify different types of systems with examples.**
 - Appeared in: S25 (Q1c, 07 marks), S24 (Q2c, 07 marks), W22 (Q2c, 07 marks)
- 23. **What is a system? Explain different types of system in brief.**
 - Appeared in: S22 (Q2b, 04 marks)

Unit 2: Mathematical Operations on Signals and Systems

Repeated Questions:

- Determine whether the system is (i) Linear (ii) Causal (iii) Time-invariant (iv) Stable:
 $y(n) = n x(n)$
 - Appeared in: S25 (Q2c OR, 07 marks), S24 (Q2c OR, 07 marks)
- Check whether the system is linear, static, time-invariant, causal, stable: $y(t) = 10x(t) + 5$
 - Appeared in: S22 (Q2c, 07 marks), W25 (Q2c OR, 07 marks)
- Find the convolution of sequences:
 $X(n) = 3\delta(n+1) - 2\delta(n) + \delta(n-1) + 4\delta(n-2)$
 $h(n) = 2\delta(n-1) + 5\delta(n-2) + 3\delta(n-3)$
 - Appeared in: S25 (Q3c, 07 marks), S24 (Q3c, 07 marks), W22 (Q3c, 07 marks)
- Compute convolution: $y(n) = x(n) * h(n)$, $x(n) = \{1, 1, 0, 1, 1\}$, $h(n) = \{1, -2, -3, 4\}$
 - Appeared in: S25 (Q3b, 04 marks), S24 (Q3b, 04 marks)
- Explain any two properties of convolution / convolution sum.
 - Appeared in: S23 (Q1c, 07 marks), S22 (Q4b, 04 marks), W25 (Q2b, 04 marks)
- Define convolution and explain initial value and final value theorem.
 - Appeared in: S25 (Q3c OR, 07 marks), S24 (Q3c OR, 07 marks)

Other Important Questions:

- Perform linear convolution of:
 - $x(n) = \{1, 1, 0, 1, 1\}$ & $h(n) = \{1, -2, -3, 4\}$
 - $x(n) = \{1, 2, 3, 1\}$ & $h(n) = \{1, 2, 1, -1\}$
 - $x(n) = \{1, 2, 1, -1\}$ & $h(n) = \{1, 2, -3, 4\}$
 - Appeared in: S23 (Q2c, 07 marks)
- Determine convolution sum using graphical method:
 $x(n) = \{1, 4, 3, 2\}$, $h(n) = \{1, 3, 2, 1\}$
 - Appeared in: W25 (Q1c, 07 marks)
- Convolve $x[n] = \{-1, 4, 3, 2, -2\}$ and $h[n] = \{1, 2, -1, 1\}$
 - Appeared in: W23 (Q1c, 07 marks)
- Find linear convolution of $x(n) = \{1, 1, 1, 1\}$ and $h(n) = \{2, 2\}$ using basic equation/graphical method.
 - Appeared in: S22 (Q4c, 07 marks)
- Check linearity of system: $y[n] = x[n] + 1/(2x[n-2])$
 - Appeared in: W23 (Q1a, 03 marks)
- Prove commutative, distributive, associative properties of convolution integral.
 - Appeared in: W23 (Q1b, 04 marks)
- Check stability of system: $y[n] = x[n] + 0.5x[n-1] + 0.25x[n-2]$
 - Appeared in: W23 (Q2b, 04 marks)
- Given $h(t) = e^{-2t}u(t)$, find output for $x(t) = e^{-4t}[u(t) - u(t-2)]$
 - Appeared in: W23 (Q2c, 07 marks)
- Given $h(t) = u(t-3)$, find output for $x(t) = u(t+2)$
 - Appeared in: W23 (Q2c OR, 07 marks)
- Check causality of system: $y(t) = \int_{-\infty}^{\infty} \{3t\} x(\tau) d\tau$
 - Appeared in: W23 (Q3a, 03 marks)
- For LTI system with $h(t) = e^{2t}u(t)$, find output for $x(t) = e^{-t}u(t)$
 - Appeared in: S22 (Q2c OR, 07 marks)
- Given difference equation $y(n) = x(n) + 0.81x(n-1) - 0.81x(n-2) - 0.45y(n-2)$, find transfer function, pole-zero plot, stability.
 - Appeared in: S23 (Q2c OR, 07 marks)
- Given $y(n) = 0.5y(n-1) + x(n)$, find system function and impulse response $h(n)$.
 - Appeared in: S22 (Q4c OR, 07 marks)
- Solve difference equation $y(n) - 0.5y(n-1) = \delta(n)$ using Z-transform.
 - Appeared in: W25 (Q4c OR, 07 marks)
- Give convolution sum and integral formulas.

- Appeared in: **W25 (Q4a, 03 marks)**
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Unit 3: Fourier, Laplace and Z-Transforms

Repeated Questions:

1. **State and prove time shifting and duality properties of continuous-time Fourier transform.**
 - Appeared in: S25 (Q4a, 03 marks), S24 (Q4a, 03 marks)
2. **Write modulation property of FT. Use frequency differentiation to find FT of $X(t) = t e^{(-at)} u(t)$.**
 - Appeared in: S25 (Q4b, 04 marks), S24 (Q4b, 04 marks), W22 (Q4b, 04 marks)
3. **Define Z-transform. Explain region of convergence (ROC).**
 - Appeared in: S25 (Q4a OR, 03 marks), S24 (Q4a OR, 03 marks), W24 (Q4a, 03 marks)
4. **Explain trigonometric Fourier series.**
 - Appeared in: S25 (Q4b OR, 04 marks), S24 (Q4b OR, 04 marks), S22 (Q3b, 04 marks)
5. **Find Fourier Series representation of full/half wave rectified sine wave.**
 - Appeared in: S25 (Q4c OR, 07 marks), W22 (Q4c OR, 07 marks)
6. **Explain Fourier series with any two properties.**
 - Appeared in: S25 (Q5a, 03 marks), S24 (Q5a, 03 marks)
7. **Find Z-transform of unit step signal / $u(-n-2) / a^{(n-2)}u(n-2)$.**
 - Appeared in: S25 (Q5b, 04 marks), S24 (Q5b, 04 marks), W22 (Q5a, 03 marks)

Other Important Questions:

8. **Find Fourier Transform of $x(t) = e^{(-2t)} \cos(5t) u(t)$.**
 - Appeared in: S25 (Q4c, 07 marks)
9. **Give relation between Fourier transform and Laplace transform.**
 - Appeared in: S24 (Q4c, 07 marks)
10. **Find Fourier Series representation for square wave.**
 - Appeared in: S24 (Q4c OR, 07 marks)
11. **State and prove sampling theorem.**
 - Appeared in: S25 (Q3a OR, 03 marks), S24 (Q3a OR, 03 marks), W22 (Q3a, 03 marks), W24 (Q5b, 04 marks), W25 (Q3c OR, 07 marks)
12. **Define Fourier transform for continuous-time signal.**
 - Appeared in: S23 (Q3a, 03 marks)
13. **Find Fourier transform of $\cos(\omega_0 t)$. Draw magnitude spectrum.**
 - Appeared in: S23 (Q3b, 04 marks)
14. **State and explain properties of ROC of Z-transform.**
 - Appeared in: S23 (Q3c, 07 marks), W22 (Q5b, 04 marks), W24 (Q4b, 04 marks), W25 (Q4c, 07 marks)
15. **Give relationship between Laplace transform and Fourier transform.**
 - Appeared in: S23 (Q3a OR, 03 marks)
16. **Using Z-transform properties, find Z-transform of: (1) $x(n) = u(-n)$, (2) $x(n) = u(-n-2)$.**
 - Appeared in: S23 (Q3b OR, 04 marks)
17. **State and prove time shifting and time-differentiation properties of Laplace transform.**
 - Appeared in: S23 (Q3c OR, 07 marks)
18. **Find Z-transform of sequence $x(n) = \{1, 2, 4, 5, 0, 7\}$ and specify ROC.**
 - Appeared in: S22 (Q3a, 03 marks)
19. **Find inverse Z-transform of $X(z) = 1/(1-1.5z^{-1}+0.5z^{-2})$ for $|z|>1$ and $|z|<0.5$.**
 - Appeared in: S22 (Q3c OR, 07 marks)
20. **Find Z-transform of $x(n) = (1/3)^n u(n)$ and sketch ROC.**
 - Appeared in: S22 (Q5a, 03 marks)
21. **Find Z-transform of $x(n) = \cos(\omega_0 n) u(n)$.**
 - Appeared in: S22 (Q5c OR, 07 marks)
22. **Find Laplace transform of $x(t) = t u(t)$.**
 - Appeared in: W24 (Q3b, 04 marks)

23. Find inverse Laplace transform of $F(s) = (2s-1)/(s^2+2s+1)$.
 - Appeared in: W24 (Q3c, 07 marks)
24. Find Fourier transform of signum function $\text{sgn}(t)$.
 - Appeared in: W24 (Q2c OR, 07 marks)
25. Find Fourier transform of rectangular pulse: $x(t) = A \text{rect}(t/T)$.
 - Appeared in: S22 (Q4b OR, 04 marks), W24 (Q3c OR, 07 marks)
26. Find Z-transform of $\sin(\omega_0 n) u(n)$.
 - Appeared in: W24 (Q4c, 07 marks)
27. Find Z-transform of $0.5^n u(n) + 0.33^n u(n)$.
 - Appeared in: W24 (Q4b OR, 04 marks)
28. Find inverse Z-transform of $X(z) = z/(3z^2-4z+1)$ for $|z|>1$.
 - Appeared in: W24 (Q4c OR, 07 marks)
29. Find DTFT of sequence $x(n) = \{1,0,4,2\}$.
 - Appeared in: W25 (Q4a OR, 03 marks)
30. Find Z-transform and ROC of $x(n) = 3^n u(n) - 2^n u(-n-1)$.
 - Appeared in: W25 (Q4b OR, 04 marks)
31. Prove convolution property of Fourier transform.
 - Appeared in: W25 (Q3b, 04 marks)
32. Find inverse Fourier transform of $X(\omega) = 2j\omega/(2+j\omega)^2$.
 - Appeared in: W25 (Q3c, 07 marks)
33. Find Fourier transform of $x(t) = e^{(-at)} u(t)$.
 - Appeared in: W25 (Q3a OR, 03 marks)
34. State and prove time shifting property of Z-transform.
 - Appeared in: W25 (Q4b, 04 marks)

Unit 4: Sampling & Reconstruction

Repeated Questions:

1. **Explain Aliasing and its effects and how to remove it.**
 - Appeared in: S25 (Q3a, 03 marks), S24 (Q3a, 03 marks), W22 (Q3a OR, 03 marks), W23 (Q4c OR, 07 marks)
2. **Determine Nyquist sampling rate and interval for $x(t) = 2 \text{sinc}(100\pi t)$.**
 - Appeared in: S25 (Q3b, 04 marks), S24 (Q3b, 04 marks), W22 (Q3b OR, 04 marks)
3. **State and prove Sampling Theorem.**
 - Appeared in: S25 (Q3a OR, 03 marks), S24 (Q3a OR, 03 marks), W22 (Q3a, 03 marks), W24 (Q5b, 04 marks), W25 (Q3c OR, 07 marks)
4. **What is aliasing? What are effects of undersampling?**
 - Appeared in: S23 (Q4a, 03 marks), S23 (Q4b, 04 marks), W25 (Q5b, 04 marks)
5. **Explain signal reconstruction from its sampled form.**
 - Appeared in: W23 (Q5a, 03 marks), W25 (Q3a, 03 marks)

Other Important Questions:

6. **A 100 Hz sinusoid $x(t)$ is sampled at 240 Hz. Has aliasing occurred? State minimum sampling frequency.**
 - Appeared in: S22 (Q2a, 03 marks)
 7. **Define: Zero-order hold, First-order hold, Ideal interpolation.**
 - Appeared in: S23 (Q4a, 03 marks)
 8. **Explain zero-order hold with mathematical representation, advantages, disadvantages.**
 - Appeared in: W23 (Q4c, 07 marks)
 9. **Explain mathematical model for reconstruction.**
 - Appeared in: S23 (Q4c OR, 07 marks)
 10. **What is zero-order hold in sampling?**
 - Appeared in: W25 (Q5a OR, 03 marks)
 11. **Draw spectra of sampled signal. Explain aliasing.**
 - Appeared in: W24 (Q5b OR, 04 marks)
 12. **Explain reconstruction of a signal from its samples.**
 - Appeared in: W25 (Q3a, 03 marks)
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Unit 5: Applications – IoT, Arduino, Modulation

Repeated Questions:

1. **Write a short note on Arduino and interfacing of sensors and actuators with Arduino.**
 - Appeared in: S25 (Q5c, 07 marks), S24 (Q5c OR, 07 marks), W22 (Q4b OR, 04 marks), W24 (Q5c OR, 07 marks)
2. **Explain the Internet of Things (IoT).**
 - Appeared in: S25 (Q5c OR, 07 marks), W22 (Q5c, 07 marks)
3. **Explain types of sensors.**
 - Appeared in: S24 (Q5c, 07 marks), W22 (Q5c OR, 07 marks), W24 (Q5a, 03 marks), W25 (Q5c OR, 07 marks)
4. **List types of actuators.**
 - Appeared in: W24 (Q5a OR, 03 marks), W23 (Q5c, 07 marks)
5. **Explain any application of modulation for communication.**
 - Appeared in: S23 (Q4c, 07 marks)

Other Important Questions:

6. **Give an example of Arduino-based minor project.**
 - Appeared in: W24 (Q5c, 07 marks)
7. **Explain interfacing of sensors and actuators with Arduino.**
 - Appeared in: W24 (Q5c OR, 07 marks)
8. **Explain input and output pins of Arduino.**
 - Appeared in: S23 (Q5a OR, 03 marks)
9. **Explain with circuit diagram temperature measurement using LM35 with LCD using Arduino + program.**
 - Appeared in: S23 (Q5c OR, 07 marks)
10. **Explain working of any system based on Arduino.**
 - Appeared in: W25 (Q3c OR, 07 marks)
11. **What is IoT? Draw block diagram of any IoT-based system.**
 - Appeared in: S23 (Q5a, 03 marks)
12. **Explain with diagram any four sensors used in IoT.**
 - Appeared in: S23 (Q5b, 04 marks)
13. **Explain with circuit diagram any application based on Arduino with sensor & actuators.**
 - Appeared in: S23 (Q5c, 07 marks)
14. **List at least 7 types of sensors used with Arduino and their applications.**
 - Appeared in: W23 (Q5c OR, 07 marks)
15. **List at least 4 types of actuators used with Arduino and their applications.**
 - Appeared in: W23 (Q5c, 07 marks)
16. **Describe various types of sensors used for IoT applications.**
 - Appeared in: W25 (Q5c OR, 07 marks)
