Total No. of printed pages = 4

ECE 181305

Roll No. of candidate 20/2/23

2023

B.Tech. 3rd Semester End-Term Examination

Electronics and Telecommunication Engineering

SIGNALS AND SYSTEMS

(New Regulation and New Syllabus)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *four* from the rest.

1. Answer the following (MCQ/ Fill in the blanks) : (10 × 1 = 10)

(i) Analog signals can be converted into discrete-time signals by

(a) Sampling (b) Coding

(c) Quantizing (d) None of the above

(ii) $y(t) = x^2(t)$ is a

(a) linear time-invariant system (b) non-linear time-invariant system

(c) linear tie varying system (d) non-causal system

(iii) The characteristics of an LSI system are completely characterized by its

(a) Step response (b) Impulse response

(c) Transfer function (d) None of the above

(iv) Aliasing occurs when the signal is

(a) Over sampled (b) Under sampled

(c) Critically sampled (d) Sampled

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(v) The trigonometric Fourier series representation of an odd function consists of

(a) Cosine terms only (b) Sine terms only

(c) Both sine and cosine terms (d) None

(vi) The spectrum of a Gaussian signal is

(a) Rectangular function (b) Triangular function

(c) Sinc function (d) Gaussian function

(vii) The convolution $u(t)^* u(t)$ is

(a) $u^2(t)$ (b) $tu(t)$

(c) $u(t^2)$ (d) $u(t)+u(t)$

(viii) For a causal LTI system to be stable, all the poles oh $H(z)$ must lie ———— in the z-plane.

(a) outside the unit circle

(b) on the unit circle

(c) inside the unit circle

(d) on both outside and inside the unit circle

(ix) The speech signal is the example of ———— dimensional signal.

(a) one (b) two

(c) three (d) none of the above

(x) The advantages of state-space analysis are ————.

(a) Analysis is done by considering initial conditions

(b) More accurate than transfer function

(c) Analysis of multi-input and multi-output system will be made easy by the state space analysis techniques

(d) All of the above

2. (a) Define signal and system. What are the major classifications of the signal? (4)

(b) What do mean by unit impulse, unit step and signum function? (3)

(c) Determine whether the following systems are Linear or Nonlinear, Shift variant or Invariant, Causal or Non-causal, Stable or unstable : (8)

(i) $y(t)= x(t+10)+ x^2(t)$

(ii) $\frac{dy(t)}{dt}+ 10\ y(t) = x(t)$.

3. (a) Explain Linear Shift-Invariant (LSI) or Linear Time-Invariant (LTI) system. Describe the properties of an LTI system. (7)

(b) Define impulse response of a system and write the expression for transfer function in terms of input signal and output signal. (4)

(c) Determine the output of an LTI system whose input signal and unit impulse response are given as follows : $x(n) = b_n u(n)$ and $h(n) = a_n u(n)$. (4)

4. (a) State and prove the Sampling theorem for Band limited signals with graphical interpretation. (8)

(b) Determine the Nyquist sampling rate and Nyquist sampling interval for the following signals :

(i) $\sin c^2(300\pi t)$

(ii) $\sin c(100\pi t) + 5 \sin c^2(200\pi t)$. (4)

(c) A signal $x(t) = \sin(200\pi t)$ is sampled at a rate of

(i) 150 Hz

(ii) 225 Hz and

(iii) 300 Hz. For each of these three cases, can you recover signal $x(t)$ from the sampled signal $x_s(t)$? (3)

5. (a) Discuss the concept of trigonometric Fourier series and derive the expressions for coefficients. (5)

(b) Obtain the Fourier transform of the following functions :

(i) Unit step function

(ii) Unit impulse function

(iii) Signum function. (5)

(c) State and prove the following properties of Fourier Transform. (5)

(i) Time shifting

(ii) Convolution in time domain

6. (a) Define Laplace transform and discuss its existence. (4)

(b) Prove that the signals $x(t) = e^{-at}u(t)$ and $x(t) = -e^{-at}u(-t)$ have the same LT but differ only in ROC. (4)

(c) Find the Inverse Laplace transform of $X(S) = \frac{1}{(s+4)(s-2)}$ if the ROC is (7)

(i) ROC : Re(s) < –4

(ii) ROC : Re(S) > 2

(iii) ROC : –4 <Re(s) < 2.

7. (a) Find the inverse Z-transform of $X(z) = \frac{z}{(z+2)(z-3)}$ when the ROC is (6)

(i) ROC : $|z| < 2$

(ii) $2 < |z| < 3$.

(b) Using Z-transforms, find $x_1(n)^* x_2(n)$, if $x_1(n) = u(n)$ and $x_2(n) = \left(\frac{1}{2}\right)^n u(n)$. (5)

(c) Distinguish between one-sided and two sided Z-transforms and its region of convergence. (4)