GENERAL SIR JOHN KOTELAWALA DEFENCE UNIVERSITY

Faculty of Engineering

Department of Electrical, Electronic and Telecommunication Engineering

BSc Engineering Degree

Semester 4 Examination – November / December 2022

(Intake 38 – ET)

ET2202 – RANDOM SIGNALS AND PROCESSES

Time allowed: 2 hours 28th November, 2022

ADDITIONAL MATERIAL PROVIDED

INSTRUCTIONS TO CANDIDATES

This paper contains 4 questions on 5 pages

Answer ALL FOUR questions

This is a closed book examination

This examination accounts for 70% of the module assessment. A total maximum mark obtainable is 100. The marks assigned for each question and parts thereof are indicated in square brackets

If you have any doubt as to the interpretation of the wordings of a question, make your own decision, but clearly state it on the script

Assume reasonable values for any data not given in or provided with the question paper, clearly make such assumptions made in the script

All examinations are conducted under the rules and regulations of the KDU

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Question 1

(a)

(i) Explain the difference between the deterministic signal and the random signal.

(2 Marks)

(ii) Explain random process in relation with random variables.

(2 Marks)

(iii) State two real wold examples of random processes.

(2 Marks)

(b) Consider an experiment of tossing a fair coin three times

X is the number of tails obtained

(i) Determine the sample space.

(2 Marks)

(ii) Determine the number of sample points.

(2 Marks)

(iii) Determine $P(X = 1)$

(3 Marks)

(iv) Determine $P(1 < X \leq 3)$

(4 Marks)

(v) Illustrate the cdf of X with explaining how each point of the diagram was obtained.

(8 Marks)

Question 2

(a) Consider the experiment of throwing a dart onto a circular plate with unit radius. Let **X be the random variable representing the distance of the point where the dart lands from the origin of the plate.**

(i) State the distribution which can be used for random variable X with reasons.

(3 Marks)

(ii) Determine the range of X.

(3 Marks)

Let a denotes radius inside the plate

(iii) Calculate P(X < a)

Let b>a denotes a radius inside the plate. (3 Marks)

(iv) Calculate P(a < X ≤ b)

(4 Marks)

(b) Let X be an exponential random variable X with parameter λ. Probability density function is given as follows:

$$f(x)=\int_0^{\infty} \lambda e^{-\lambda x} dx$$

(i) Calculate the mean of the random variable X.

(4 Marks)

(ii) Calculate the variance of the random variable X.

(4 Marks)

(c) Let a random variable X denote the outcome of throwing a fair die. Find the mean and variance of X.

(4 Marks)

Question 3

(a) Explain a stationary process.

(5 Marks)

(b) A random process X(t) is defined by $X(t)=A\cos(2\pi f_c t)$. Where A is a Gaussian distributed random variable of zero mean and variance σ^2 . This random process is applied to an ideal integrator producing the output $y(t)=\int_0^t X(\tau)d\tau$. Assume the probability density function of X is $\frac{1}{\sigma\sqrt{2\pi}} e^{\frac{-1}{2}\left(\frac{x}{\sigma}\right)^2}$

(i) Determine the pdf of the output Y(t) at a particular time t.

(7 Marks)

(ii) Determine whether or not Y(t) is stationary.

(8 Marks)

(c) Explain the difference between the covariance function and auto covariance function.

(5 Marks)

Question 4

(a) Explain Additive Gaussian White Noise.

(5 Marks)

(b) Explain the relationship between autocorrelation function and the power spectral density function.

(5 Marks)

(c) Explain how thermal noise can be defined as a random signal

(5 Marks)

(d) If the autocorelation function of a random signal is an impulse, determine the power spectral density function of the signal.

(10 Marks)

End of question paper