K. J. Somaiya Institute of Technology, Sion, Mumbai-22
(Autonomous College Affiliated to University of Mumbai)

Jan- Feb ~~Nov – Dec~~ 2026
.Program: _ B. Tech__Scheme IIB | II
~~Regular~~/Supplementary Examination: TY Semester:V
Course Code: EXC504_IIB_and Course Name: Random Signal Analysis
Date of Exam: ~~31/12/25~~ 06/02/26 Duration: 02.5 Hours Max. Marks: 60

Instructions:
(1)All questions are compulsory.
(2)Draw neat diagrams wherever applicable.
(3)Assume suitable data, if necessary.

Q. No.	Question	Max. Marks	CO	BT level
Q 1	Solve any **two** questions out of three: (05 marks each)	10		
a)	A company has two containers of raw material samples, labeled Container A and Container B. Container A holds 3 black samples (defective) and 5 white samples (non-defective).Container B holds 7 black samples (defective) and 1 white sample (non-defective).To decide which container to inspect, a coin is tossed: If the coin shows Heads, samples are taken from Container A.If the coin shows Tails, samples are taken from Container B.During an inspection, two samples drawn are both found to be defective (black). Determine the probability that the samples were drawn from Container A, given this observation?		1	Ap
b)	A transmission channel has a per-digit error probability p = 0.01. Estimate the probability of more than 1 error in 10 received digits using (i) Binomial Distribution; (ii) Poisson Distribution		2	U
c)	The lifetimes of two independent electronic components, say Component X and Component Y, are found to follow exponential distributions due to random failure mechanisms. The lifetime (in years) of Component X and Component Y has the probability density function, given by $f(x) = 2e^{-2x}$ $for\ x \geq 0$ $f(y) = 3e^{-3y}$ $for\ y \geq 0$ $f(x) = 0$ $for\ x < 0$ $f(y) = 0$ $for\ y < 0$ Assuming both components are connected in series in a circuit (so the system fails when either component fails), let the random variable. Z = X + Y. represent the total operational time of both components before complete system replacement. Determine the probability density function (PDF) of Z.		3	Ap
Q 2	Solve any **two** questions out of three: (05 marks each)	10		
a)	If X = cos θ , Y = sin 2θ ,where θ is uniformly distributed over (0,2π) prove that X and Y are uncorrelated		4	Ap

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b)	Elaborate different types of random processes. Justify the significance of Correlation and Covariance with respect to real world applications.		5	U
c)	Determine the nature of the state of the Markov Chain with the transition probability matrix given by $\begin{bmatrix} 0 & 1 & 0 \\ 0.5 & 0 & 0.5 \\ 0 & 1 & 0 \end{bmatrix}$			
Q.3	Solve any **two** questions out of three. (10 marks each)	20		
a)	A digital communication system transmits binary symbols '0' and '1' over a noisy channel. The probability that symbol '0' is correctly received as '0' is 0.9, and the probability that symbol '1' is correctly received as '1' is 0.85. Due to system design, the probability of transmitting '0' is 0.6. Determine the following: i) The probability that a '1' is received. ii) The probability that '1' was transmitted given that '1' was received. iii) The overall probability of error in transmission.iv) Comment on whether this channel is symmetric or asymmetric, and justify your answer.		1	Ap
b)	If the joint distribution function of (X, Y) is given by $F(X,Y) = (1-e^{-x})(1-e^{-y}), \quad x>0, y>0$ Determine (i) the marginal density functions of X and Y; (ii) Comment whether X and Y are independent; (iii) P (1<X<3, 1<Y<2)		4	Ap
c)	If a random process {x(t)} is given by X(t) = 10 cos (100t + θ) where θ is uniformly distributed over (-π ,π). Prove that {x(t)} is correlation ergodic.		5	Ap
Q.4	Solve any **two** questions out of three. (10 marks each)	20		
a)	Most graduate business schools require applicants for admission to take the Graduate Management Admission Council's GMAT Examination. Scores on the GMAT are roughly normally distributed with a mean of 527 and a standard deviation of 112. Determine the probability of an individual scoring above 500 in GMAT. Estimate how high must an individual score on the GMAT in order to score in the highest 5%		2	U, Ap
b)	Let X and Y be two independent continuous random variables each uniformly distributed over the interval [0,1]. Define two new random variables:		3	Ap

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	$$U = X + Y, \qquad V = \frac{X}{X+Y}$$ (i)Derive the joint probability density function $f_{u,v}(u, v)$. (ii) Determine the marginal PDF of U for the range $0 < U < 2$.			
c)	A Markov Chain has three states S = {1,2,3} with the one-step transition probability matrix: $$P^{(1)} = \begin{bmatrix} 0.6 & 0.3 & 0.1 \\ 0.2 & 0.5 & 0.3 \\ 0.0 & 0.4 & 0.6 \end{bmatrix}$$ Using the Chapman-Kolmogorov equation, (i)Compute the two-step transition probability matrix $P^{(2)}$.(ii)Determine the probability that the chain starting in state 1 is in state 3 after two steps.		6	U, Ap

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