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Question Paper Code: R1M22

B.E./B.Tech. DEGREE EXAMINATION, APRIL / MAY 2025

Fourth Semester

Electronics and Communication Engineering

R21UMA422- PROBABILITY, STATISTICS AND MATHEMATICAL STRUCTURES

(Regulations R2021)

Duration: Three hours

Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. The limiting form of a Binomial distribution is CO6- U
(a) Exponential (b) Poisson (c) Normal (d) None of the above
2. If X and Y are independent random variables then $\text{Cov}(X, Y)$ is CO6- U
(a) 0 (b) 1 (c) -1 (d) ∞
3. The degrees of freedom for Normal distribution is _____ CO6- U
(a) $(n-1)(n-2)$ (b) $n-2$ (c) $n-3$ (d) $n-1$
4. Large sample size is _____ CO6- App
(a) 30 (b) >30 (c) <30 (d) none of the above
5. SSE for Latin square design is CO6- U
(a) TSS-SSC-SSR (b) TSS-SSC (c) 0 (d) TSS-SSC-SSR-SSK
6. Choose the correction factor _____ CO3- App
a) T^2/N b) T/N c) T^2/N d) TN
7. If $R_{XY}(\tau) = 0$ then X(t) and Y(t) are called CO6 - U
(a) Poisson Process (b) Stationary Process
(c) Orthogonal Process (d) WSS Process

8. If the Random Process $\{X(t)\}$ with mean has Auto correlation function $R(\tau) = 16 + 9e^{-|\tau|}$ Then the Variance of the process is CO4 - App
- (a) 16 (b) 25 (c) 6 (d) 9
9. How many “T” are occurred in $(Q \wedge (P \rightarrow Q)) \rightarrow P$ CO6 - U
- (a) 4 (b) 3 (c) 1 (d) 2
10. If P:Mark is rich, Q: Mark is happy then the symbolic form of the statement is Mark is poor but happy CO5 - App
- (a) $\neg(P \wedge Q)$ (b) $P \wedge \neg Q$ (c) $\neg P \wedge Q$ (d) $P \vee \neg Q$

PART – B (5 x 2= 10 Marks)

11. A discrete random variable X with probability distribution CO1- App

X	0	1	2	3	4	5
P(X)	a	3a	5a	7a	9a	11a

Using the probability mass function, Calculate the value of the constant ‘ a ‘ and mean value.

12. A sample of size 10 has mean 58, standard deviation 18.4 and population mean 50, Compute the calculated value of ‘t’ distribution. CO2 - Ana
13. Why a 2x2 Latin Square is not possible? Explain CO6 -U
14. Compute the mean Square value of the auto correlation function CO4 - App
- $$R(\tau) = 36 + \frac{5}{1 + 5\tau^2}$$
15. Compute PCNF for $\neg(P \rightarrow Q)$ CO5 -App

PART – C (5 x 16= 80 Marks)

16. (a) (i) A Random Variable X has the following probability distribution CO1- App (8)

X=x	0	1	2	3	4	5	6	7
P(X=x)	0	K	2 K	2 K	3 K	K ²	2 K ²	7 K ² + K

Using probability mass function Compute the following

- (i) ‘K’ (ii) $P(X > 6)$, (iii) distribution function.
- (ii) Using the probability mass function of Poisson distribution , CO1 - App (8)
- Compute the moment generating function and hence find mean and variance

Or

- (b) (i) Obtain the Correlation coefficient for the following heights (in inches) of fathers X and their sons Y. CO1 - App (8)

X	65	66	67	67	68	69	70	72
Y	67	68	65	68	72	72	69	71

- (ii) State and Prove the memory less property for an Exponential distribution CO1 - App (8)

17. (a) 2000 students at college level were graded according to their I.Q. and their economic conditions. Identify the distribution what conditions can you draw from the following data? CO2- Ana (8)

Economic conditions	I.Q. level		
	High	Low	Total
Rich	620	380	1000
Poor	550	450	1000
Total	1170	830	2000

- (ii) The table gives the number of aircraft accidents that occurred during the various days of the week. Test whether the accidents are uniformly distributed over the week. CO2- App (8)

Days	Mon	Tue	Wed	Thu	Fri	Sat
No.of. accidents	14	18	12	11	15	14

Or

- (b) Two independent samples of sizes 9 and 7 from a normal population had the following values of the variables. CO2- Ana (16)

Sample I	18	13	12	15	12	14	16	14	15
Sample II	16	19	13	16	18	13	15	--	--

Identify the sampling distribution, Do the estimates of the population variance differ significantly.

18. (a) Analyze the following of Latin square design experiment,.

CO3 -Ana (16)

A (12)	D (20)	C (16)	B (10)
D (18)	A (14)	B (11)	C (14)
B (12)	C (15)	D (19)	A (13)
C (16)	B (11)	A (15)	D (20)

The letters A,B,C,D denote the treatments and the figures in brackets denote the observations,

Or

- (b) The following data represent the number of units production per day turned out by different workers using 4 different types of machines. CO3- Ana (16)

		Machine Type			
Workers		A	B	C	D
	1	44	38	47	36
	2	46	40	52	43
	3	34	36	44	32
	4	43	38	46	33
	5	38	42	49	39

Test whether the five men differ with respect to mean productivity and test whether the mean productivity is the same for the four different machine types.

19. (a) (i) If the auto correlation function of the random binary transmission is given by CO4 -App (8)

$$R_{xx}(\tau) = \begin{cases} 1 - \frac{|\tau|}{T} & ; |\tau| \leq T \\ 0 & ; |\tau| \geq T \end{cases} \quad \text{Find the}$$

Power spectral density function.

- (ii) Using the properties of auto correlation function, compute the CO4 -App (8)

Mean , Mean Square value and Variance of $R_{xx}(\tau) = 25 + \frac{4}{1 + 6\tau^2}$

Or

- (b) (i) The cross power spectrum of a real random process $X(t)$ and $Y(t)$ is given by CO4 -App (8)

$$S_{XY}(\omega) = \begin{cases} a + ib\omega, & |\omega| < 1 \\ 0, & \text{otherwise} \end{cases}.$$

Compute the cross correlation function

- (ii) Compute power spectral densities of the following auto CO4 -App (8)

correlation function $R_{XX}(\tau) = e^{-\alpha\tau^2}, \alpha > 0$

20. (a) (i) Compute the PCNF and PDFN for $(\neg P \rightarrow R) \wedge (Q \leftrightarrow P)$ CO5 -App (8)

- (ii) Using rules of inference theory and CP Rule, derive CO5 -App (8)

$$P \rightarrow (Q \rightarrow S), \neg R \vee P, Q \Rightarrow R \rightarrow S$$

Or

- (b) (i) Prove the following by direct method CO5 -App (8)

$$(\exists x)(P(x) \wedge Q(x)) \Rightarrow (\exists x)P(x) \wedge (\exists x)Q(x)$$

- (ii) Show that the following argument is valid CO5-App (8)

“My father praises me only if I can be proud of myself.

Either I do well in sports or I cannot be proud of myself.

If I study hard then I cannot do well in sports.

Therefore If father praises me the I do not study hard.”

