**ANNA UNIVERSITY QUESTIONS SUBJECT NAME: PROBABILITY AND RANDOM PROCESS (PRP)**

**Regulation (2017)**

 **UNIT-I**: **RANDOM VARIABLES**

**TOPIC:** **Discrete Random Variables**

1. A Random Variable X has the following probability distribution

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| x | -2 | -1 | 0 | 1 | 2 | 3 |
| P(x) | 0.1 | K | 0.2 | 2k | 0.3 | 3k |

 (i)Find k (ii)Evaluate Evaluate P(X < 1) , P(X < 2), P(-1 < X ≤ 2) and P(-2<X<2) (iii)Find the CDF of X and (iv) Evaluate the mean of X

 2) A Random Variable X has the following probability distribution function

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| x | 0 | 1 | 2 | 3 | 4 | 5 |  6 |  7 |
| P(x) | 0 | K | 2K | 2k | 3K |  |  | +k |

 (i)Find the value of k (ii) Evaluate P(X<6), P(X)(iii) find P

 (iv) If P(X)> find the minimum value of c. **(A/M 2012,14) (N/D 2012)**

 3) The probability function of an infinite discrete distribution is given by P(X=j) = , j=1, 2, 3,…

 Verify that the total probability is 1 and find the mean and variance of the distribution. Find also

 P(X is even), P(X) and P(X is divisible by 3). **(N/D 2011)**

 4) If p.m.f of a RV x is given by P(X=x) = kx3, x = 1,2,3,4. Find the value of k,

 P , mean and variance of X . **(A/M 2015)**

5) Show that for the probability distribution function 

 E(X) does not exist. **(N/D 2012)**

6)The p.m.f of RV X is defined asP(X=0) =3C2, P(X=1)=4C-10C2, P(X=2) = 5C-1 , where C > 0, and P(X = r) = 0 if r ≠ 0,1,2. Find (i) C (ii) P(0<X<2/X>0) (iii) distribution function of X (iv) the largest value of x for which F(x) <1/2. **(A/M 2010)**

**TOPIC:** **Continuous Random Variables**

1. If the density function of X is f (x) =, find (i) the value of k (ii) distribution function of X (iii) P(X≥0) **(N/D 2011)**
2. The distribution function of a RV X is given by (x) = 1-(1+x), x≥0. Find the density function,

Mean and variance of X.

1. If the density function of a Continuous Random Variable X is given by

 find (i) the value of k (ii) P(0.2<X<1.2) (iii) P(0.5<X<1.5/X≥1) (iv) distribution function of X **(A/M 2011)**

1. A Continuous Random Variable X that can assume any values between x=2 and x=5 has p.d.f given by f(x)=k(1+x). Find P(X<4) **(A/M 2015)**
2. If ,, for what value of b is f(x) a valid pdf ? Also find F(x). **(N/D 2015)**
3. The cumulative distribution function of a RV X is given by 

 Draw the graph of the CDF. Compute P(X >), P ()

1. If a random variable X has a cumulative distribution function 

 Find the probability density function, the value of c and P(1 < x < 2).

**TOPIC: Moment Generating Functions and Mathematical Expectation**

1. Find the MGF and moment for the distribution whose p.d.f is f(x) =k ,0 .

Hence find the mean and variance.  **(M/J 2013)**

1. A Continuous Random Variable X has the p.d.f f(x)=k , . Find the order moment about origin , MGF and mean and variance of X.  **(N/D 2015)**
2. Find the MGF of the RV X having the pdf

  **(N/D 2013)**

1. Let X be a continuous R.V with probability density function 

Find (i) the cumulative distribution function of X (ii) Moment generating function Mx(t) of X (iii) P(X < 2) (iv) E(X**). (A/M 2016)**

1. Find the moment generating function and rth moment for the distribution whose probability density function is  Also find the first three moments about mean**. (N/D 2016)**
2. The probability distribution function of a random variable X is given by Find the mean, variance and third moment about origin.**(N/D 2016)**
3. If the moments of the r.v X are defined by E(Xr) =0.6, r = 1,2,3…. Show that P(X=0)=0.4, P(X=1)=0.6 and P(X ≥ 2)=0. (N/D 15)

**TOPIC: Binomial Distribution**

1. Find the M.G.F of the binomial random variable with parameters m and p and hence find its mean and variance. **(A/M 2011) (N/D 2012) (A/M 2015)**
2. 6 dies are thrown 729 times. How many times do you except at least three die to show a five (or) a six? **(N/D 2013)**
3. In a large consignment of electric bulbs, 10% are defective. A Random Sample of 20 is taken for inspection. Find the probability that
4. All are good bulbs.
5. At most there are 3 defective bulbs
6. Exactly there are 3 defective bulbs **(M/J 2013)**

1. Assume that 50% of all engineering students are good in mathematics. Determine the probabilities that among 18 engineering students (1) exactly 10 (2) atleast 10 are good in maths. **(A/M 2016)**
2. It is known that the probability of an item produced by a certain machine will be defective is 0.05. If the produced items are sent to the market in packets of 20, find the number of packets containing at least, exactly and at most 2 defective items in a consignment of 1000 packets. **( N/D 2016)**
3. An office has 4 phone lines. Each is busy about 10% of time. Assume that the phone lines act independently. (i) What is the probability that all 4 phones are busy? (ii) What is the probability that atleast 2 of them are busy? **(A/M 13)**
4. A coin is biased so that a head is twice as likely to appear as a tail. If the coin is tossed 6 times, find the probability of getting (i) exactly 2 heads (ii) atleat 3 heads (iii) atmost 4 heads. **(A/M 16)**

**TOPIC: Poisson Distribution**

1. By calculating the MGF of Poisson distribution with parameter , prove that the mean and variance of the Poisson distribution are equal. **(M/J 2014)** **(N/D 2014) (A/M 2010)**
2. The number of monthly breakdowns of a computer is a RV having a Poisson distribution with

Mean equal to 1.8 .Find the probability that this computer will function for a month

(i) Without a breakdown (ii) with only one breakdown **(N/D 2012)**

1. If X is a Poisson variate such that P(X=2) =9P(X=4) + 90P(X=6). Find (i) Mean and E () (ii) P(X) **(M/J 2012)**
2. A Manufacturer of pins knows that 2% of his products are defective. If he sells pins in boxes of 100

 And guarantees that not more than 4 pins will be defective, what is the probability that a box fails

 to meet the guaranteed quality? **(N/D 2013)**

1. The number of typing mistakes that a typist makes on a given page has a Poisson distribution with

 Mean of 3 mistakes. What is the probability that she makes **(N/D 2015)**

1. Exactly 7 mistakes
2. Fever than 4 mistakes
3. No mistakes on a given page
4. Message arrive at a switch board in a poisson manner at an average rate of six per hour . Find the probability for each of the following events:

(i) exactly two messages arrive within one hour

(ii) no message arrives within one hour

(iii) at least three messages arrive within one hour (**A/M 2015) (N/D 2016)**

1. Suppose that telephone calls arriving at a particular switch board follow a Poisson process with an average of 5 calls coming per minute. What is the probability that up to a minute will elapse unit 2 calls have come into the switch board? **(A/M 2011)**
2. Ten percent of the tools produced in a certain manufacturing company turn out to be defective. Find theprobability that in a sample of 10 tools chosen at random, exactly 2 will be defective by using (i) Binomial distribution (ii) The poisson approximation to the binomial distribution **(N/D 2015)**
3. Derive poisson distribution from binomial distribution.

**TOPIC: Geometric Distribution**

1. Describe the situations in which geometric distributions could be used. Obtain its moment generating function. **(A/M 2010)**
2. Find theMGF of geometrically distributed random variable and hence find its mean and variance. **(A/M 2015)**
3. Derive mean and variance of a geometric distribution. Also establish the forgetfulness property of the geometric distribution. **(A/M 2011) (A/M 2016)**
4. A coin is tossed until the first head occurs. Assuming that the tosses are independent and the probability of a head occurring is ‘p’. Find the value of ‘p’, so that the probability that an odd number of tosses required is equal to 0.6 .can you find a value of ‘p’, so that the probability is 0.5 that an odd number of tosses are required. **(N/D 2010)**
5. If the probability that an applicant for a driver’s license will pass the road test on any given trial is 0.8, what is the probability that he will finally pass the test (i) on the 4th trial (2) in fewer than 4 trials? **(N/D 2012)**
6. Suppose that a trainee soldier shoots a target in an independent fashion. If the probability that

The target is shot on any one shot is 0.7,

1. What is the probability that the target would be hit on tenth attempt?
2. What is the probability that it takes him less than 4 shots?
3. What is the probability that it takes him an even number of shots?  **(M/J 2014)**

**TOPIC: Exponential Distribution**

1. Find the moment generating function of an exponential random variable and hence

 find its mean and variance. **(M/J 2014)** **(M/J 2012)**

1. The time (in hours) required to repair a machine is exponentially distributed with parameter. What is the probability that the repair time exceeds 2h? What is the conditional probability that a repair takes at least 10h given that its duration exceeds 9h?  **(N/D 2013)**
2. The milage which car owners get with a certain kind of radical tire is a random variable having an exponential distribution with mean 40,000 km. Find the probabilities that one of these tires will last at least 20,000 km and at most 30,000km. **(A/M 2015)**
3. The life time X of particular brand of batteriesisexponentially distributed with mean of 4 weeks. Determine

(i)The mean and variance of X

(ii) What is the probability that the battery life exceeds 2 weeks?

(iii)Given that the battery has lasted 6 weeks, What is the probability that it will last another 5

 weeks?  **(N/D 2015)**

1. A component has an exponential time to failure distribution with mean of 10,000 hours.

(i)The component has already been in operation for its mean life. What is the probability that it will fail by 15,000 hours?

(ii)At 15,000 hours the component is still in operation. What is the probability that it will operate for another 5000 hours? **(N/D 2015)**

1. The life (in years) of a certain electrical switch has an exponential distribution with an average life of  If 100 of these switches are installed in different systems, find the probability that at most 30 fail during the first year. **(A/M 2016)**
2. State and prove forgetfulness property of exponential distribution. Using this property, Solve the following problem:

The length of the shower on a tropical island during rainy season has an exponential distribution with parameter 2, time being measured in minutes. If a shower has already lasted for two minutes, What is the probability that it will last for at least one more minute? **(N/D 2016)**

1. Suppose X has an exponential distribution with mean equal to 10. Find the value of x such that

P(X < x) = 0.95

1. The length of time a person speaks over phone follows exponential distribution with mean 6 mins. What is the probability that the person will talk for (i) more than 8 mins (ii) between 4 and 8 mins. **(A/M 16)**
2. Find mgf, mean and variance of the two parameter exponential distribution whose density function is given by 

**TOPIC: Uniform Distribution**

1. Find the MGF of Uniform Distribution. Hence find its mean and variance. **(M/J 2013)**
2. Trains arrive at a station at 15 min intervals starting at 4 a.m. If a passenger arrive at a station at a time that is uniformly distributed between 9.00 and 9.30 , find the probability that he has to wait for the train for (1) less than 6 mins (2) more than 10 mins. **(M/J 2014)**
3. If a continuous Random Variable X follows uniform distribution in the interval and a continuous RV, Y follows exponential distribution with parameter λ. Find λ such that  **(N/D 2013)**
4. If X is a Random Variable with a continuous distribution function Prove that has a uniform distribution in (0,1), further if **(N/D 2010)**

 Find the Range of Y, Corresponding to the Range

1. Let X be a uniformly distributed R.V over [-5,5]. Determine (i) (ii) 

 (iii)Cumulative distribution function of X (iv)Var(X) **(A/M 2016)**

1. If X is uniformly distributed with E(X) 1 and Var(X) = 4/3. Find P(X < 0). (A/M 15)
2. A r.v X is uniformly distributed over (0,10). Find (i) P(X < 3), P(X >7) and P(2< X < 5)

 (ii) P(X = 7) **(A/M 13)**

**TOPIC: Gamma Distribution**

1. Define Gamma Distribution and find its mean and variance.  **(N/D 2011)**
2. In a certain city, the daily consumption of electric power in millions of kilowatt hours can be treated as a Random Variable having Gamma distribution with parameters and α=3.

 If the power plant of this city has a daily capacity of 12 million kilowatt hours, what is the probability that this power supply will be inadequate on any given day? **(M/J 2012)**

**TOPIC: Normal Distribution**

1. Find the MGF of N() Normal Distribution and hence find its mean and variance **(N/D 2015)**
2. Find the nth moment about mean of normal distribution. **(N/D 2014)**
3. In a Normal Distribution 31% of the items are under 45 and 8% are over 64.Find the mean and variance of the distribution. **(N/D 2014)**
4. The peak temperature T, as measured in degrees Fahrenheit, on a particular day is the Gaussian (85, 10) random variable. What is P(T), P(T) and P(70 100)? **(A/M 2015)**
5. The average percentage of marks of candidates in an examination is 42 with a standard deviation of 10. If the minimum mark for pass is 50% and 1000 candidates appear for the examination, how many candidates can be expected to get the pass mark if the marks follow Normal Distribution? If it is required , that double the number of the candidates should pass, what should be the minimum mark for pass? **(N/D 2015)**
6. The annual rainfall in inches in a certain region has a normal distribution with a mean of 40 and variance of 16. What is the probability that the rainfall in a given year is between 30 and 48 inches? **( N/D 2016)**
7. Assume that the reduction of a person’s oxygen consumption during a period of transcendental meditation (T.M) is a continuous r.v X normally distributed with mean 37.6 cc/min and S.D 4.6 cc/min. Determine the probability that during a period of T.M a person’s oxygen consumption will be reduced by (i) atleast 44.5 cc/min (ii) atmost 35.0 cc/min (iii) anywhere from 30.0 to 40.0 cc/min **(N/D 12)**
8. Let X and Y be independent normal variates with mean 45 and 44 and S.D 2 and 1.5 respectively. What is the probability that randomly chosen values of X and Y differ by 1.5 or more? **( N/D 11)**
9. The marks obtained by a number of students for a certain subject is assumed to be normally distributed with mean 65 and S.D 5. If 3 students are taken at random from this set, what is the probability that exactly 2 of them will have marks over 70?  **(A/M 10,11)**
10. If X and Y are independent r.v follows N(8,2) and N(12,4√3) respectively. Find the value of λ such that P () = P () **(N/D 10)**

**TOPIC: Function of a random variable**

1. If the random variable X is uniformly distributed over (-1,1), find the density function of 
2. If *X* is a standard normal variate , find the pdf of  **(N/D 2015)**
3. The RV *X* has exponential distribution with density function . Find the pdf of (i) Y = 3X+5 (ii) . **(N/D 2012)**
4. If X is a uniform random variable in (-2,2), find the pdf of Y = |X| and E(Y**). (N/D 2011)**
5. If X and Y are independent r.v’s each normally distributed with mean zero and variance σ2, find the pdf of 

**OTHER QUESTIONS**

1. If the density function of a continuous R.V. X is given by

 

(i) find the value of a (ii) find the cdf of X. (iii) If and are 3 independent observation of X, what is the probability that exactly one of these 3 is greater than 1.5? **[A/ M 04, N/D 08**]

1. Let X be a discrete r.v whose cumulative distribution function is 

(a)Find

(b)Find the probability mass function. **[A/M 2000]**

1. A continuous random variable X has the p.d.f find the moment of X about the origin. Hence find the mean and variance of X. **[A/M 03]**
2. The probability of a component’s failure is 0.05 out of 14 components. What is the probability that (i) atmost 3 will fail (ii) atleast 3 will fail?
3. Out of 800 families with 4 children each, how many families would be expected to have

 i) 2 boys 2 girls ii) atleast 1 boy iii) atmost 2 girls iv) children of both gender. **[A/M 09]**

1. The atoms of a radioactive element are randomly disintegrating. If every gram of this element, on an average, emits 3.9 alpha particles per second, what is the probability that during the next second the number of alpha particles emitted from 1 gram is (i) atmost 6 (ii) atleast 2

 (iii) atleast 3 and atmost 6 ?  **[ N/D 07]**

1. A and B shoot independently until each has hit his own target. The probabilities of their hitting the target at each shot are  and  respectively. Find the probability that B will require more shots than A.
2. Starting at 5.00 a.m. every half hour there is a flight from San Francisco airport to Los Angeles International Airport. Suppose that none of these planes is completely sold out and that they always have room for passengers. A person who wants to fly to L.A. arrives at the airport at a random time between 8.45 a.m and 9.45 a.m. Find the probability that she waits (i) atmost 10 mins. (ii) atleast 15 mins. **[N/D 07]**
3. Suppose the duration X in minutes of long distance calls from your home, follows exponential law with PDF 

 find mean of X and variance of X. **[N/D 05]**

1. The daily consumption of milk in excess of 20,000 gallons is approximately exponentially distributed with  The city has a daily stock of 35,000 gallons. What is the probability that of two days selected at random, the stock is insufficient for both days. **[A/M 03]**
2. State and prove additive property of binomial distribution
3. State and prove additive property of Poisson distribution
4. State and prove additive property of normal distribution

**TOPIC :Baye’s Theorem**

1. A bag contains 5 ball and it is not known how many of them are white. Two balls are drawn at random from the bag and they are noted to be white. What is the chance that all the balls in the bag are white?
2. There are 3 true coins and 1 false coin with ‘head’ on both sides. A coin is chosen at random and tossed 4 times. If heads occurs all the 4 times, what is the probability that the false coin has been chosen and used?
3. For a certain binary communication channel, the probability that a transmitted ‘0’ is received as a’0’ is 0.95 and the probability that a transmitted ‘1’is received as ‘1’ is 0.90.If the probability that a ‘0’ is transmitted is 0.4, find the probability that (i) a ‘1’ is received and (ii) a ‘1’ was transmitted given that a ‘1’ was received.
4. In a coin tossing experiment, if the coin shows head, 1 die is thrown and the result is recorded. But if the coin shows tail,2 dice are thrown and their sum is recorded. What is the probability that the recorded number will be 2?
5. An urn contains 10white and 3 black balls. Another urn contains 3white and 5black balls. Two balls drawn at random from the first urn and placed in the second urn and then 1 ball is taken at random from the latter. What is the probability that it is a white ball?
6. A bolt is manufactured by 3 machines A,B and C.A turns out twice as many items as B, and machines B and C produce equal number of items.2% of bolts produced by A and B are defective and 4% of bolts produced by C are defective. All bolts are put into 1 stock pile and 1 is chosen from this pile. What is the probability that it is defective?

**UNIT-II: TWO DIMENTIONAL RANDOM VARIABLE**

**PART-B**

**TOPIC: TWO DIMENSIONAL DISCRETE R.V**

1. The joint distribution of X and Y is given by Find the marginal distributions and conditional distributions . **[N/D-2015,16]**
2. The joint probability mass function of (X,Y) is given by

. Find all the marginal and conditional probability distributions.Also find the probability distribution of X+Y. [**N/D-2014,15]**

1. The joint distribution of X and Y is given by Find the marginal distribution of X and Y, the conditional distribution of X given Y =1 and the conditional distribution of Y given X =2..
2. The joint CDF of two discrete random variables X and Y is given by  . Find the joint probability mass function and the marginal probability mass functions of X and Y.
3. Three balls are drawn at random without replacement from a box containing 2 white, 3 red and 4 blue balls. If X denotes the number of white balls drawn and Y denotes the number of red balls drawn, find the probability distribution of X and Y. **[A/M-2015,16]**
4. If X and Y are independent poisson random variable with respective parameters  and . Calculate the conditional distribution of X, given that X + Y = n. **[A/M-2011]**

**TOPIC: TWO DIMENSIONAL CONTINUOUS R.V**

1. Two dimensional R.V (X,Y) have the joint probability density function Find the marginal and conditional distributions.

 **[N/D-2011, A/M 2010]**

1. The joint pdf of random variable X and Y is given by Determine the value of Find marginal pdf of X.
2. The joint pdf of random variable X and Y is given by

Calculate the conditional density of X given Y=1

1. Given Evaluate ‘c’ and and

 **[N/D-2010]**

1. Given the joint density function

 find the marginal densities g(x), h(y) and the conditional density f(x/y) and evaluate

 **[A/M-2013,16]**

1. The joint pdf of a 2-D R.V (X,Y) is ,

Find (i)P(X<1Y<3) (ii)P(X+Y<3) (iii)P(X<1/Y<3)

1. The joint pdf of a 2D R.V (X,Y) is f(x,y)=Find the marginal and conditional densities.Also find (i) P(X > 1/2) (ii) P( Y< X) (iii)P(X +Y)

 **[A/M-2014,15]**

1. The joint pdf of a 2-D R.V (X ,Y) is given by f(x,y) = Compute P (), P(), P() , P(Y<X): P(X

and P(X +Y) . **[A/M-2012]**

1. Given the joint density function of x and y as 

Find the distribution of X+Y **[N/D-2016]**

1. The joint probability density function of a two dimensional random variable (X,Y) is given by . Find the conditional mean and variance of Y given X.

 **[A/M2016,17]**

1. The joint probability density function of a two dimensional random variable (X,Y) is given by . Are X and Y independent? **[ N/D 2015]**
2. If the distribution function of a two dimensional random variable (X,Y) is given by . Find the marginal densities of X and Y. Are X and Y independent?. Find P(1< X <3, 1< Y <2) **[ N/D 2015]**

**TOPIC: COVARIANCE and CORRELATION**

1. A joint probability mass function of the discrete R.Vs X and Y is given as Compute the covariance of X and Y
2. Two R.V X and Y having the joint probability function

 Find **[N/D-2011]**

1. Let X and Y be R.Vs having joint density function **[A/M-2010]**

Find thecov(X,Y)

1. The joint pdf of random variable X and Y is given by

(i)Find the marginal density function of X and Y.

(ii)What is the covariance of X and Y ? **[A/M-2015]**

1. The joint pdf of random variable (X,Y) is . Find cov(X,Y). **[A/M-2014]**
2. The joint pdf of random variable (X,Y) is . Find (i) Marginal density functions X and Y (ii) Correlation coefficient between X and Y. **[N/D-2010]**
3. The joint pdf of random variable (X,Y) is . Find k, cov(X,Y). Are X and Y independent? **[A/M-2012]**
4. If X and Y are random variables having the joint density function . Find the correlation coefficient between X and Y.
5. Two independent random variable (X,Y) are defined by and. Show that U = X+Y and V = X-Y are uncorrelated. **[A/M-2013]**

**TOPIC: TRANSFORMATION OF 2-D R.V**

1. Let X and Y be independent random variables both uniformly distributed on (0,1). Calculate the probability density of X+Y.
2. If X and Y are independent R.Vs with pdf’s and respectively find the density function of and Are U and V independent. **[N/D-2013, A/M 16,17]**
3. If X and Y are independent R.Vs with pdf’s and respectively find the density function of X-Y. **[N/D-2011]**
4. If X and Y are independent R.Vs with pdf’s

(i) Find the density functions of and (ii) Are U and V independent? (iii) What is P(U > 0.5). **[N/D-2012]**

1. If X and Y each follows an exponential distribution with parameter 1 and are independent , find

The pdf of U=X-Y  **[N/D-2015]**

1. The joint p.d.f of the continuous R.V (X,Y) is given as Find the p.d.f of the R.V U = X/Y
2. The joint p.d.f of the continuous R.V (X,Y) is given as Find the p.d.f of the R.V U = XY **[A/M-2012,15]**
3. Two independentrandom variable (X,Y) are defined by and. Find the density function of Z = XY. **[A/M-2011]**
4. If X and Y are independent continuous random variable. Show that the pdf of U = X+Y is given by **[N/D 2010]**

**TOPIC: CORRELATION COEFFCIENT AND REGRESSION LINES**

1. Calculate the coefficient of correlation for the following data: **[N/D-2016]**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| X | 55 | 56 | 58 | 59 | 60 | 60 | 62 |
| Y | 35 | 38 | 37 | 39 | 44 | 43 | 44 |

1. Calculate the correlation co-efficient for the following data. **[A/M-2015]**

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

1. The marks obtained by 10 students in Mathematics (x) and Statistics (y) are given below. Find thetwo regression lines. Also find y when x = 55 **[A/M-2014]**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| x | 60 | 34 | 40 | 50 | 45 | 40 | 22 | 43 | 42 | 64 |
| y | 75 | 32 | 33 | 40 | 45 | 33 | 12 | 30 | 34 | 51 |

9. Obtain the equations of the regression lines from the following data. Hence find the coefficient of correlation between X and Y. Also estimate the value of Y when X=38 and X when Y =18

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| X | 22 | 26 | 29 | 30 | 31 | 31 | 34 | 35 |
|  Y | 20 | 20 | 21 | 29 | 27 | 24 | 27 | 31 |

1. If the independent R.V X and Y have the variances 36 and 16 respectively, find the correlation coefficient,where U=X+Y and V=X-Y **[N/D-2012]**
2. IfX and Y are uncorrelated random variables with the variances 16 and 9 respectively, find the correlation coefficient between X+Y and X-Y **[A/M-2012]**
3. The regression equation of X on Y is If the mean value of Y is 44 and the variance of X where of the variance of Y. Find the mean value of X and correlation

co-efficient.**[A/M-2011]**

42. The two regression lines are 8X-10Y+66=0, 40X-18Y-214=0. The variance of X is 9. Find the mean values of X and Y.Also find the correlation coefficient between the variables X and Y and variance of Y. **[A/M-2015,16]**

43.The two regression lines are 3X+12Y=19 and3Y+9X=46. Find the mean values of X and Y. Also find the correlation coefficient between the variables X and Y.**[A/M-2013]**

44. The random variables X and Y are related by X-6=Y and 0.64X-4.08=0. Find the mean of X and Y and correlation coefficient between X and Y.**[A/M-2015]**

45. Tworandom variable X and Y have The joint pdf 

Find the correlation coefficient and equations of two lines of regression. **[A/M-2016,17]**

1. If the density function is defined by , then obtain the regression equation of Y on X for the distribution. **[N/D-2015]**

**UNIT 3**

**RANDOM PROCESS**

**PART-A**

1. Defined random process. **(AU N/D 2013)**
2. Defined random process and give an example. **(AU M/J 2016)**
3. Define stochastic process. **(AU N/D 2014)**
4. Define a stationary process. **(AU M/J 2016R[13])**
5. Define SSS process. **(AU N/D 2015R[13])**
6. Define a strictly stationary random process. **(AU N/D 2012)**
7. Define first order stationary process. **(AU N/D 2015)**
8. Give an example of evolutionary random process. **(AU A/M 2015R[13])**
9. Prove that a first order stationary process has a constant mean. **(AU A/M 2011)**
10. Define a wide sense stationary process. **(AU A/M 2010 M/J 2012 2013)**
11. When is the random process said to be mean ergodic ? **(AU N/D 2011)**
12. State the properties of an ergodic process. **(AU M/J 2014)**
13. Consider the random process where  is a random variable with density function . Check whether or not the process is wide sense stationary. **(AU N/D 2010)**
14. Consider the random process with uniformly distributed in the interval . Check whether X(t) is stationary or not. **(AU M/J 2016)**
15. State the postulates of Poisson process. **(AU N/D 2010 A/M 2011)**
16. Prove that sum of two independent Poisson process is again a Poisson process. **(AU N/D 2012 A/M 2015)**
17. Write down any two properties of Poisson process. **(AU N/D 2015R[13])**
18. Define a semi random telegraph signal process. **(AU A/M 2015R[13])**
19. Define Markov process. **(AU N/D 2013 2014 A/M 2015 M/J 2016R[13])**
20. Define a Markov chain and give an example. **(AU A/M 2010)**
21. Let be a stochastic matrix. Check whether it is regular. **(AU N/D 2016R[13])**

**PART-B**

**TOPIC: STATIONARY PROCESS**

1. Examine whether the random process is a wide sense stationary if *A* and  are constant and  is uniform distributed random variable in . **(AU A/M 2010 N/D 2011 N/D 2015 A/M 2016R[13])**
2. Classify a random process with examples. **(AU M/J 2016)**
3. A random process X(t) defined by , , where A and B are independent random variables each of which takes a value -2 with probability 1/3 and a value 1 with probability 2/3. Show that X(t) is wide sense stationary. **(AU A/M 2011,2017 M/J 2013 N/D 2015)**
4. The process whose probability distribution under certain condition is given by . Find the mean and variance of the process. Is the process first-order stationary? **(AU N/D 2010 N/D 2011 N/D 2012 M/J N/D 2014 N/D 2016R[13])**
5. If the two Random variables  and  are uncorrelated with zero mean and , show that the process  is wide sense stationary. What are mean and autocorrelation of X(t) ? **(AU N/D 2013 2014)**
6. Examine whether  where *A* and *B* are random variables such that ;;,is wide sense stationary. **(AU M/J 2015 A/M 2015R[13])**
7. If  is a WSS process with autocorrelation , determine the second order moment of the RV. **(AU M/J 2012)**
8. Given a random variable  with density and another random variable  uniformly distributed in  and independent of  and , prove that is a wide sense stationary process. **(AU M/J 2016)**
9. Mention any three properties each of auto correlation and of cross correlation function of a wide sense stationary process. **(AU M/J 2013)**
10. If the process  is a Poisson process with parameter, obtain . Is the process first order stationary? **(AU N/D 2010 N/D 2012 M/J 2014)**

**TOPIC: MORKOV PROCESS**

1. The transition probability matrix of a Markov chain , having the three states  is  and the initial distribution is . Find and . **(AU A/M 2010 N/D 2016R[13])**
2. Consider a markov chain with transition probability matrix Find the limiting probabilities of the system. **(AU A/M 2017)**
3. Two boys and 2 girls are throwing a ball from one to another. Each boy throws the ball to other boy with probability 1/2 and to each girl with probability 1/4. On the other hand, each girl throws the ball to each boy with probability 1/2 and never to the other girl. In the long run, how does each receive the ball? **(AU N/D 2015)**
4. There are 2 white marbles in Urn A and 3 red marbles in Urn B. At each step of the process, a marble from each urn and 2 marbles selected are interchanged. The state of the related Markov chain is the number of red marbles in Urn A after the interchange. What is the probability that there are 2 red marbles in Urn A after 3 steps? In the long run, what is the probability that there are 2 red marbles in Urn A? **(AU A/M 2015R[13])**
5. A man either drives a car or catches a train to go to office each day. He never goes 2 days in a row by train, but if he drives one day, then the next day he is just as likely to drive again as he is to travel by train. Now suppose that on the first day of the week, the man tossed a fair die and drove to work if and only if a 6 appeared. Find (i) the probability that he takes a train on the fourth day (ii) the probability that he takes a train on the third day (iii) the probability that he drives to work on the fifth day (iv) the probability that he drives to work in the long run. **(AU N/D 2015R[13] M/J 2016R[13])**
6. Three out of every four trucks on the road are followed by a car, while only one out of every five cars is followed by a trucks, what fraction of vehicles on the road are trucks?
7. A gambler has Rs.2 He bet Rs.1 at a time and wins Rs.1 with probability ½. He stops playing if he loses Rs.2 or wins Rs.4.
8. What is the tpm of the related markov chain?
9. What is the probability that he has lost his money at the end of 5 plays?
10. What is the probability that game lost more than 7 plays?
11. A salesman territory consists of three cities A,B and C. He never sells in the same city on successive days. If he sells in city-A, then the next day he sells in city B .However if he sells in either city-B or City-C the next day he is twice as likely to sell in city-A as in the other city in the long run how after does he sell each of the cities?
12. An engineer analyzing a series of digital signals generated by a testing system observes that only 1 out of 15 highly distorted signals follows a highly distorted signal , with no recognizable signals between, whereas 20 out of 23 recognizable signals follow recognizable signals, with no highly distorted signals between. Given that only highly distorted signals are not recognizable, find the fraction of signals that are highly distorted?

**TOPIC: POISSON PROCESS**

1. State the postulates of a Poisson process and derive the probability distribution. Also prove that the sum of two independent Poisson processes is a Poisson process. **(AU N/D 2011)**
2. Define a Poisson process. Show that the sum of two Poisson processes is a Poisson process. **(AU M/J 2013,16)**
3. Prove that the differences of two independent Poisson process is not a Poisson process. **(AU M/J 2016)**
4. Prove that the interval between two successive occurrences of a Poisson process with parameter  has an exponential distribution with mean . **(AU A/M 2011)**
5. Find the autocorrelation function of the Poisson process.  **` (AU M/J 2015)**
6. If is a Poisson process, then prove that correlation coefficient between and is . **(AU N/D 2015)**
7. Suppose the customers arrive at a bank according to Poisson process with a mean rate of 3 per minute, find the probability that during a time interval of two minutes. (1) Exactly four customers arrive (2) Greater than four customers arrive (3) Fewer four customers arrive. **(AU N/D 2015R[13])**
8. If customers arrive at a counter in accordance with a Poisson process with a mean rate of 2 per minute, find the probability that the interval between 2 consecutive arrivals is (1) more than 1 minute (2) between 1 minute and 2 minute and (3) 4 min or less. **(AU M/J 2012)**
9. A radioactive source emits particles at a rate of 5 per minute in accordance with Poisson process. Each particle emitted has a probability 0.6 of being recorded. Find the probability that 10 particles are recorded in 4 minutes period. **(AU A/M 2015R[13])**
10. Customers arrive at a grocery store in a Poisson manner at an average rate of 10 customers per hour. The amount of money that each customer spends uniformly distributed between $ 8.00 and $ 20.00. what is the average total amount of money that customers who arrive over a two-hour interval spend in the store? What is the variance of this total amount? **(AU N/D 2016R[13])**
11. Assume that the number of messages input to a communication channel in an interval of duration *t* seconds, is a Poisson process with mean . Compute (1) The probability that exactly 3 messages will arrive during 10 seconds interval. (2) The probability that the number of message arrivals in an interval of duration 5 seconds is between 3 and 7. **(AU A/M 2010)**
12. A fisherman catches a fish at a poisson rate of 2 per hour from a large lake with lots of fish. If he starts fishing at 10.00 a.m. What is the probability that he catches one fish by 10.30 a.m. and three fishes by noon? **(AU A/M 2017)**

**TOPIC: RANDOM TELEGRAPH PROCESS**

1. Define a semi random telegraph signal process and prove that it is an evolutionary process. **(AU M/J 2013 N/D 2015R[13])**
2. Define a semi random telegraph signal process and random telegraph signal process and prove also that the former is evolutionary and the latter is wide sense stationary. **(AU N/D 2014)**
3. Define Random telegraph signal process and prove that it is wide sense stationary. **(AU N/D 2013 A/M 2015R[13],2017)**
4. Define a Random telegraph process. Show that it is covariance stationary process. **(AU M/J 2015)**
5. Prove that a random telegraph signal process  is a wide sense stationary process when is a random variable which is independent of , assumes values -1 and +1 with equal probability and. **(AU N/D 2010 N/D 2012 M/J 2014 M/J 2016R[13])**
6. Find the autocorrelation function of the random telegraph process. **(AU N/D 2016R[13])**

**PRP**

**UNIT-4**

**PART-A**

1. Prove that for a WSS process,is an even function of . **[AU A/M 2011,N/D 2011, N/D 2012]**
2. Prove that the auto correlation process function is an even function of. **[AU N/D 2015]**
3. Write any two properties of autocorrelation. **[AU N/D 2014]**
4. The auto correlation function of a stationary random process is. Find the mean and variance of the process. **[AU A/M 2010 2011 2012]**
5. The auto correlation function of a stationary random process is. Find the mean and variance of the process. **[AU N/D 2011]**
6. Find the variance of the stationary ergodic process, whose auto correlation function is given by. **[AU N/D 2015[R13] A/M 2014]**
7. If. Find then mean and variance of X. **[AU A/M 2015]**
8. Find the variance of the stationary processwhose auto correlation function is given by. **[AU N/D 2010, N/D 2012]**
9. Find the power spectral density function of the stationary process whose autocorrelation function is given by. **[AU A/M 2010]**
10. A random process whereis a constant and K is uniformly distributed over (0,2). Find the auto correlation function of . **[AU A/M 2013]**
11. State Wiener-Khinchine theorem. **[AU N/D 2015,N/D 2013]**
12. Write the Wiener-Khintchine relation. **[AU N/D 2014]**
13. Define power spectral density function of a stationary random process. **[AU N/D 2013A/M 2015]**
14. Find the auto correlation function whose spectral density is. **[AU A/M 2015[R13]]**
15. Prove that the spectral density of a real random process is an even function.  **[AU A/M 2015[R13]]**
16. The power spectral density of a random process is given byFind its auto correlation function: **[AU A/M 2016[R13]]**
17. State any two properties of cross correlation function. **[AU N/D 2010 A/M 2015[R13]]**
18. Define Cross-correlation function and state any two of its properties. **[AU A/M 2014]**
19. Define cross correlation function of and. When do you say that they are independent? **[AU A/M 2013]**
20. Prove that. **[AU A/M 2012]**
21. Prove that  **[AU A/M 2016[R13]]**

**PART – B**

1. Prove that random process and defined by and  are jointly wide sense stationary if A and B are uncorrelated random variables with means 0 and same variances and  is constant. **[AU A/M 2014]**
2. Find the autocorrelation function of the periodic time function. **[AU A/M 2010]**
3. The autocorrelation function of the random binary transmission  is given by  for and 0 for . Find the power spectrum of the process. **[AU A/M 2010]**
4. Find the power spectral density of the random process whose auto correlation function is  **[AU N/D 2010 N/D 2012]**
5. Find the spectral density of a random binary transmission process where autocorrelation function is. **[AU A/M 2015[R13]]**
6. The auto correlation function of an ergodic process is . Obtain the spectral density of. [ **AU A/M 2016[R13]**]
7. The random binary transmission processis a WSS process with zero mean and auto correlation function, where T is a constant. Find the mean and variance of the time average ofover (0, T). Is mean ergodic? **[AU N/D 2014]**
8. Find the autocorrelation function of the process for which the power spectral density is given by =1+for <1 and =0 for >1. **[AU A/M 2010]**
9. Given the power spectral density of a continuous process as. Find the mean square value of the process. **[AU N/D 2011,A/M 2015[R13], A/M 2016[R13]]**
10. The power spectrum of a wide sense stationary process is given by. Find the auto correlation function. **[AU A/M 2015]**
11. The power spectrum of a WSS process is given by. Find the auto correlation function. **[AU N/D 2015[R13]]**
12. Find the auto correlation function of the WSS processwhose spectral density is given by. **[AU N/D 2015]**
13. If and are two random processes with auto correlation function andrespectively then prove that. Establish any two properties of auto correlation function. **[AU N/D 2010 N/D 2012,A/M2016[R13]]**
14. Consider two random process  and  where  is a random variable uniformly distributed over. Prove that. **[AU A/M 2015, A/M 2015[R13]]**
15. State and prove Weiner-khintchine Theorem. **[AU N/D 2010, A/M N/D 2011,AU A/M 2011 20132014]**
16. State and prove Weiner-khintchine Theorem and hence find the power spectral density of a WSS process  which has an autocorrelation  **[AU N/D 2011]**
17. The autocorrelation function of the random process is given by  Find power spectral density of the process. **[AU N/D 2011 2013 ]**
18. The Auto correlation function of a WSS process is given by . Determine the power spectral density of the process. **[AU A/M 2011, N/D 2013, N/D 2015[R13]]**
19. Find the power spectral density function whose autocorrelation function is given by. **[AU A/M 2012]**
20. Find the power spectral density of the WSS process with Auto correlation function. **[AU N/D 2014]**
21. Find the power spectral density of a random signal with auto correlation function. **[AU A/M 2015]**
22. Find the auto spectral density of a WSS random processwhose auto correlation function is. **[AU N/D 2015]**
23. The power spectral density function of a zero mean WSS process is given by  . Find and show that and are uncorrelated. **[AU A/M 2011]**
24. If the power spectral density of a WSS process is given by. Find the auto correlation function of the process. **[AU N/D 2013,2014]**
25. A stationary random process with mean 2 has the auto correlation function. Find the mean and variance of. **[AU A/M 2012]**
26. Let and be both zero-mean and WSS random processes. Consider the random process defined by. find
27. The Auto correlation function and the power spectrum of if andare jointly WSS.
28. The power spectrum of if andare orthogonal **[AU A/M 2012]**
29. Define spectral density of a stationary random process. Prove that for a real random process has power spectral density is an even function. **[AU A/M 2013]**
30. If the process  is defined as where and are independent WSS processes, prove that (1) and (2) 

 **[AU N/D 2013]**

1. A random processis given by, where *A* and *B* are random variables such that;. Find the power spectral density of the process. **[AU N/D 2014]**
2. If where are two independent normal random variables with and is a constant, prove that is a strict sense stationary process of order 2. **[AU A/M 2015]**
3. A stationary process has an autocorrelation function given by. Find the mean value, mean-square value and variance of the process. **[AU N/D 2015[R13]]**
4. If prove that. Hence prove that. **[AU N/D 2015[R13]]**
5. Two random process andare defined as follow and where A, B and  are constants,  is a uniform random variable over. Find the cross correlation function of  and . **[AU A/M 2013,N/D 2015R[13]]**
6. and****are zero mean and stochastically independent random processes having autocorrelation function ****and ****respectively. Find (1) The autocorrelation function of ****and**.** (2) The cross correlation function of  and . **[AU A/M 2010]**
7. The cross-power spectrum of real random processesand is= . Find the cross correlation function.

 **[AU N/D 2010, AU A/M 2011,A/M N/D 2011, A/M2016[R16]]**

1. Determine the cross correlation function corresponding to the cross-power density spectrum, where is a constant. [ **AU N/D 2015**]
2. The cross-power spectrum of real random processes  and  is where a and b are constants. Find the cross correlation function. **[AU A/M 2013, N/D 2015]**
3. The cross-correlation function of two processesandis given by where A,B and are constants. Find the cross-power spectrum . **[AU A/M 2012]**

**PRP**

**UNIT-5**

**PART-A**

1. Check whether the system y(t) = X3(t) is linear. (N/D 2015)
2. Compare band-limited white noise with ideal low-pass filtered white noise. (N/D 2015)
3. Define casual system. (N/D 2015)
4. Define transfer function of a system. (N/D 2015)
5. Check whether the system y(t) = 2X(t) is linear. (A/M 2015)
6. Define a linear system with random output. (A/M 2015)
7. State any two properties of cross power density spectrum. (A/M 2015)
8. Define white noise. (A/M 2011, N/D 2013, 2014)
9. The auto correlation function of a stationary random process is. Find the mean and variance of the process. (N/D 2014)
10. Define a system. When is it called a linear system? (A/M 2014)
11. Define Band-limited white noise. (N/D 2010, 2012, A/M 2014)
12. Define linear time invariant system. (N/D 2013, A/M 2010, 2013)
13. State the convolution form of the output of a linear time invariant system. (A/M 2013)
14. Prove that the system  is a linear time-invariant system. (A/M 2012)
15. What is the unit impulse response of a system? Why is it called so? (A/M 2012)
16. Find the system Transfer function, if a linear time invariant system has an impulse function  (A/M 2011, N/D 2012)
17. State any two properties of a linear time invariant system. (N/D 2011)
18. If {X(t)} and {Y(t)} in the system  are WSS process, how are their auto correlation functions related. (N/D 2011)
19. State autocorrelation function of the white noise. (A/M 2010)
20. If Y(t) is the output of an linear time invariant system with impulse response h(t), then find the cross correlation of the input function X(t) and output function Y(t). (N/D 2010)

**PART – B**

1. If the output of the input X(t) is defined as  prove that X(t) and Y(t) are related by means of convolution integral. Find the unit impulse response of the system**. (N/D 2015)**
2. A circuit has an impulse response  . Evaluate SYY(ω) in terms of SXX(ω) .

 **(N/D 2015, A/M 2015, 2016)**

1. Given that  where {Y(t)} is a WSS process, prove that 
2. Find the output auto correlation function.  **(N/D 2015)**
3. A linear time invariant system has an impulse response  Find the output auto correlation function RYY(τ) corresponding to an input X(t). **(N/D 2010, 2015, 2016)**
4. If {X(t)} is a WSS process and if prove that  **(A/M 2012, N/D 2015)**
5. RXY(τ) = RXX(τ) \* h(-τ) and
6. RYY(τ) = RXY(τ) \* h(τ) where \* denotes convolution
7. SXY(ω) = SXX(ω) H\*(ω) where H\*(ω) is the complex conjugate of H(ω)
8. SYY(ω) = SXX(ω) |H(ω)|2 **(N/D 2011, A/M 2013, 2015, 2015(R8))**
9. A random process X(t) is the input to a linear system whole impulse response is h(t) = 2e-t , t ≥ 0 . If the auto correlation of the process is RXX(τ) = e-2|τ|, determine the cross correlation RXY(τ) and RYX(τ).

 **(N/D 2015, A/M 2013,2015(R8))**

1. If the input to a time invariant stable linear system is a wide sense stationary process, prove that the output will also be a wide sense stationary process. **(N/D 2010, 2011, 2012, A/M 2013, 2014, 2015, 2015(R8))**
2. Given RXX(τ) = Ae-α|τ| and  where . Find the spectral density of the output Y(t). **(N/D 2012, A/M 2014,2015)**
3. Let Y(t) = X(t) + N(t) be a wide sense stationary process where X(t) is the actual signal and N(t) is the zero mean noise process with variance σN2, and independent of X(t). Find the power spectral density of Y(t).

**(A/M 2015(R8))**

1. Check whether the following systems are linear (i) *y(t) = t x(t)* (ii) *y(t) = x2(t).* **(N/D 2014)**
2. The power spectral density of a signal x(t) is Sx(ω) and its power is P. Find of power of the signal x(t).

  **(N/D 2014)**

1. A linear system is described by the impulse response  Assume an input signal whose autocorrelation function is Bδ(τ). Find the autocorrelation mean and power of the output. **(A/M 2011, N/D 2015)**
2. If {X(t)} is the input voltage to a circuit and {Y(t)} is the output voltage, {X(t)} is a stationary random process with  and RXX(τ) = e-α|τ| . Find the mean  and power spectrum SYY(ω) of the output if the power transfer function is given by  **(N/D 2013(R8), 2014)**
3. Prove that the spectral density of any WSS process is non-negative. **(N/D 2013,2013(R8))**
4. If where A is a constant, θ is a random variable with a uniform distribution in (-π , π) and {N(t)} is a band limited Gaussian white noise with power spectral density

 

Find the power spectral density Y(t). Assume that {N(t)} and θ are independent. **(A/M 2010, 2011, 2016, N/D 2010, 2012, 2013(R8),2014)**

1. A wide sense stationary noise process N(t) has an autocorrelation function  where P is a constant. Find its power spectrum. **(A/M 2013)**
2. Consider a system with transfer function  . An input signal with autocorrelation function is fed as input to the system. Find the mean and mean-square value of the output. **(A/M 2011, 2012)**
3. A stationary random process X(t) having the autocorrelation function  is applied to a linear system at time t = 0 where f(τ) represent the impulse function. The linear system has the impulse response of h(t) = e-bt u(t) where u(t) represents the unit step function. Find RXX(τ). Also find the mean and variance of Y(t). **(A/M 2011, 2012)**
4. If {X(t)} is the input voltage to a circut and {Y(t)} is the output voltage, {X(t)} is a stationary random process with  and RXX(τ) = e-2|τ| . Find the mean  and power spectrum SYY(ω) of the output if the power transfer function is given by  **(N/D 2010, 2012)**
5. For a input-output linear system (X(t), h(t), Y(t)), derive the cross correlation function RXY(τ) and the output autocorrelation function RYY(τ). **(N/D 2011)**
6. Assume a random process X(t) is given as input to a system with transfer function

 H(ω) = 1 for –ω0 < ω < ω0. If the autocorrelation function of the input process is  Find the autocorrelation function of the output process. **(A/M 2010, 2016)**