INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Name	:	**PROBABILITY & STATISTICS**
Course Code	:	**A30008**
Class	:	II B. Tech I Semester
Branch	:	MECH
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Course Coordinator	:	Mrs. L. Indira, Associate Professor
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OBJECTIVES

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited.

In line with this, Faculty of Institute of Aeronautical Engineering, Hyderabad has taken a lead in incorporating philosophy of outcome based education in the process of problem solving and career development. So, all students of the institute should understand the depth and approach of course to be taught through this question bank, which will enhance learner's learning process.

S No	QUESTION	Blooms taxonomy level	Course Outcomes
	UNIT – I **SINGLE RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS**		
Part - A (Short Answer Questions)			
1	If X is Poisson variate such that p(x=1) =24p(x=3). Find the mean	Evaluate	4
2	Find the probability distribution for sum of scores on dice if we throw two dice	Evaluate	4
3	Out of 24 mangoes, 6 mangoes are rotten. If we draw two mangoes. Obtain probability distribution of number of rotten mangoes that can be drawn.	Analyze	4
4	Determine the binomial distribution for which the mean is 4 and variance 3	Understand	4
5	If X is normally distributed with mean 2 and variance 0.1, then find $P(\|x-2\| \geq 0.01)$?	Evaluate	4
6	If X & Y is a random variable then Prove E[X+K]= E[X]+K ,where 'K' constant	Understand	2
7	Prove that $\sigma^2 = E(X^2) - \mu^2$	Understand	2
8	Explain probability distribution for discrete and continuous	Analyze	3
9	If X is Discrete Random variable then Prove that Var (a X +b) = a^2 var(X)	Understand	3
10	Write the properties of the Normal Distribution	Analyze	5
11	Write the importance and applications of Normal Distribution	Apply	5

12	Define different types of random variables with example	Remember	3
13	Derive variance of binomial distribution	Evaluate	4
14	Derive mean of Poisson distribution	Evaluate	4
15	Explain about Moment generating function	Analyze	5
Part - B (Long Answer Questions)			
1	A random variable x has the following probability function: x 0 1 3 4 5 6 7 P(x) 0 k 2k 2k 3k k^2 $7k^2$+k Find the value of k (ii) evaluate p(x<6), p(x>6)	Evaluate	3
2	Let X denotes the minimum of the two numbers that appear when a pair of fair dice is thrown once. Determine the (i) Discrete probability distribution (ii) Expectation (iii) Variance	Understand & Evaluate	3
3	A random variable X has the following probability function: X: -2, -1, 0, 1, 2, 3 P(x): 0.1, K, 0.2, 2K, 0.3, K Then find (i) k (ii) mean (iii) variance (iv) P(0 < x < 3)	Evaluate	3
4	A continuous random variable has the probability density function $f(x)=\begin{cases} kxe^{-\lambda x}, \; for\; x \geq 0, \lambda > 0 \\ 0, otherwise \end{cases}$ Determine (i) k (ii) Mean (iii) Variance	Evaluate	3
5	If the PDF of Random variable f(x) = $k(1-x^2), 0<x<1$ then find (i) k (ii) p[0.1<x<0.2] (iii) P[x>0.5]	Evaluate	3
6	If the masses of 300 students are normally distributed with mean 68 kg and standard deviation3 kg how many students have masses: greater than 72 kg (ii) less than or equal to 64 kg (iii) between 65 and 71 kg inclusive	Analyze	5
7	Out of 800 families with 5 children each, how many would you expect to have (i)3 boys (ii)5 girls (iii)either 2 or 3 boys ? Assume equal probabilities for boys and girls.	Understand & Evaluate	4
8	If a Poisson distribution is such that $P(X=1).\frac{3}{2}P(X=3)$, find (i) $P(X \geq 1)$ (ii) $P(X \leq 3)$ (iii) $P(2 \leq X \leq 5)$.	Evaluate	4
9	Average number of accidents on any day on a national highway is 1.8. Determine the probability that the number of accidents is (i) at least one (ii) at most one	Analyze & Evaluate	4
10	In a Normal distribution, 7% of the item are under 35 and 89% are under 63. Find the mean and standard deviation of the distribution.	Evaluate	5
Part - C (Problem Solving and Critical Thinking Questions)			
1	When the classical definition of probability fails.	Analyze	2
2	The function f(x)=Ax^2 In 0<x0<1 is valid probability density function then find the value of A.	Evaluate	3
3	Define Normal distribution	Understand	5
4	Explain about Moments	Analyze	6
5	Derive mean deviation from the mean for Normal Distribution	Evaluate	5
6	What is the area under the whole normal curve?	Analyze	5
7	In which distribution the mean, mode and median are equal.	Analyze	5
8	The mean and variance of a binomial variable X with parameters n and p are 16 and Find $P(X \geq 1)$	Evaluate	4
9	Where the traits of normal distribution lies.	Analyze	5

10	Write the properties of continuous random variable	Understand	2
UNIT - II **MULTIPLE RANDOM VARIABLES, CORRELATION &REGRESSION**			
Part – A (Short Answer Questions)			
1	State the properties of joint distribution function of two random variable	Analyze	5
2	The equations of two regression lines obtained in a correlation analysis are 3x+12y=19,3y+9x=46. Find means of x and y	Evaluate	5
3	Given n=10, $\sigma_x = 5.4, \sigma_y = 6.2$ and sum of the product of deviation from the mean of X and Y is 66 find the correlation co-efficient	Evaluate	5
4	From the following data calculate (i) correlation c coefficient (ii) standard deviation of Y bxy=0.85, byx=0.89, $\sigma_x = 3$	Evaluate	6
5	If $r_{12} = 0.77, r_{13} = 0.72, r_{23} = 0.52$ Find the multiple correlation coefficient.	Evaluate	5
6	Determine the probability of getting at least 60 heads when 100 coins are tossed.	Understand & Evaluate	6
7	Explain about random vector concepts	Analyze	6
8	If a random variable W=X+Y where X and Y are two independent random variables what is the density function of W	Analyze	6
9	Explain types of correlations	Remember	7
10	Write the properties of rank correlation coefficient	Analyze	7
11	Write the properties of regression lines	Analyze	7
12	Write the difference between correlation and regression	Remember	7
13	The rank correlation coefficient between the marks in two subjects is 0.8.the sum of the squares of the difference between the ranks is 33.find the number of students	Evaluate	7
14	Find the angle between the regression lines if S.D of Y is twice the S.D of X and r=0.25	Evaluate	7
15	Derive the angle between the two regression lines	Evaluate	7
Part - B (Long Answer Questions)			
1	Consider the joint probability density function f(x, y) = xy, 0 < x < 1, 0 < y < 2. Find marginal density function	Evaluate	6
2	Two independent variable X and Y have means 5 and 10 and variances 4 and 9 respectively. Find the coefficient of correlation between U and V where U=3x+4y, V=3x-y	Understand & Evaluate	7
3	The probability density function of a random variable x is $f(x) = \frac{1}{2}\exp\left[-\frac{x}{2}\right], \quad x > 0$. Find the probability of 1 < x < 2.	Evaluate	6
4	Let X and Y random variables have the joint density function f(x, y)=2,0<x<y<1then find marginal density function	Evaluate	6
5	**Find** the rank correlation coefficient for the following ranks of 16 students (1,1),(2,10),(3,3),(4,4),(5,5),(6,7),(7,2),(8,6),(9,8),(10,11),(11,15),(12,9),(13, 14), (14,12), (15,16), (16,13)		
6	**Calculate** the coefficient of correlation between age of cars and annual maintain cost and comment: Years: 2, 4, 6, 7, 8, 10, 12 Rupees: 1600, 1500, 1800, 1900, 1700, 2100, 2000		
7	For 20 army personal the regression of weight of kidneys (Y) on weight of heart (X) is Y=3.99X+6.394 and the regression of weight of heart on weight of kidneys is X=1.212Y+2.461. **Find** the correlation coefficient between the two variable and also their		

	means		
8	From 10 observations on price X and supply Y the following data was obtained **Find** coefficient of correlation, line of regression of Yon X and X on Y		
9	If the variance of X is 9.The two regression equations are 8X-10Y+66=0 and 40X-18Y-214=0. **Find** correlation coefficient between X and Y and standard deviation of Y.		
Part – C (Problem Solving and Critical Thinking)			
1	Derive the angle between the two regression lines	Evaluate	7
2	If θ is the angle between two regression lines then show that $\sin\theta \le 1-r^2$	Apply	7
3	What is the marginal distributions of X and Y.	Analyze	6
4	Write the normal equations of straight line	Analyze	7
5	Find mean value of the variables X and Y and coefficient of correlation from the following regression equations 2Y-X-50=0, 3Y-2X-10=0	Evaluate	7
6	Define regression and give its uses	Remember	7
7	What are normal equations for regression lines?	Analyze	7
8	When the Regression coefficient is independent	Analyze	7
9	Find correlation coefficient if bxy=085y, byx=089x σ_x =3	Evaluate	7
10	When the coefficient of correlation is maximum	Analyze	7
UNIT-III **SAMPLING DISTRIBUTIONS AND TESTING OF HYPOTHESIS**			
Part - A (Short Answer Questions)			
1	Explain different Types and Classification of sampling	Analyze	8
2	Write about Point Estimation, Interval Estimation	understand	9
3	What is the maximum error one can expect to make with probability 0.9 when using mean of a random sample of size n=64 to estimate the means of a population with σ^2 =256	understand	9
4	A random sample of 500 apples was taken from a large consignment and 60 were found to be bad, find the standard error.	Evaluate	9
5	Three masses are measured as 62.34,20, 48, 35. 97 kgs with S.D 0.54,0.21,0.46 kgs. Find the mean and S.D of the sum of masses.	Evaluate	9
6	What is the value of correction factor if n=5 and N=200.	Apply	9
7	Find the value of finite population correction factor for n=10 and N=100.	Evaluate	9
8	Write a short note on Hypothesis, Null and Alternative with suitable examples	understand	9
9	Write a short Note on Type I & Type II error in sampling theory	understand	9
10	Prove that Sample Variance is not an Unbiased Estimation of Population Variance	understand	9
11	Write Properties of t-distribution	Analyze	10
12	Explain about Chi-Square	Analyze	10
13	Write a short note on Distinguish between t, F, Chi square test	understand	10
14	Explain about Bayesian estimation	Analyze	9
15	Compare Large Samples and Small sample tests	Create	10
Part – B (Long Answer Questions)			
1	The mean of a random sample is an unbiased estimate of the mean of the population 3,6, 9,15,27. (i) List of all possible samples of size 3 that can be taken without replacement from the finite population. (ii) Calculate the mean of the each of the samples listed in (iii) And	Apply	8

	assigning each sample a probability of 1/10.		
2	An ambulance service claims that it takes on the average 8.9 minutes to reach its destination In emergency calls. To check on this claim the agency which issues license to Ambulance service has then timed on fifty emergency calls getting a mean of 9.2 minutes with 1.6 minutes. What can they conclude at 5% level of significance?	Apply	9
3	A sample of 400 items is taken from a population whose standard deviation is 10.The mean of sample is 40.Test whether the sample has come from a population with mean 38 also calculate 95% confidence interval for the population	Apply	9
4	The means of two large samples of sizes 1000 and 2000 members are 67.5 inches and 68.0 inches respectively. Can the samples be regarded as drawn from the same population of S.D 2.5 inches	Apply	9
5	Experience had shown that 20% of a manufactured product is of the top quality. In one day's production of 400 articles only 50 are of top quality .Test the hypothesis at 0.05 levels.	Analyze & Evaluate	9
6	A sample of 26 bulbs gives a mean life of 990 hrs. With S.D. of 20 hours. The manufacture claims that the mean life bulb is 1000 hrs. is the sample not up to the standard	Apply	10
7	In a one sample of 10 observations the sum of squares of deviations from mean was 90 and other sample of 12 observations it was 108 .test whether the difference is significant at 5% level of significance.	Apply	10
8	The no. of automobile accidents per week in a certain area as follows: 12,8,20,2,14,10,15,6,9,4 are these frequencies in agreement with the belief that accidents were same in the during last 10 weeks.	Apply	10
9	Two independent samples of 7 items respectively had the following values	evaluate	10

Sample I	11	11	13	11	12	9	12	14
Sample II	9	11	10	13	9	8	10	-

10	A die is thrown 264 times with the following results .show that the die is unbiased	Understand	10

No appeared on die	1	2	3	4	5	6
Frequency	40	32	28	58	54	52

Part – C (Problem Solving and Critical Thinking)

1	Which error is called producer's risk?	Understand	9
2	Which error is called consumer's risk.	Understand	9
3	When the single tailed test is used.	Analyze	9
4	What is test statistics for testing single mean?	Analyze	9
5	How to calculate limit for true mean.	Analyze	9
6	If p=0.15 q=0.85 n=10 find confidence limits	Evaluate	9
7	What must be sample size to apply t test.	Analyze	8
8	If $\bar{x}$ =47.5, $\mu = 42.1, s = 8.4, n = 24$ find t. What is shape of t	Evaluate	10
9	What is the range of F distribution?	Understand	10
10	Which distribution is used to test the equality of population means?	Analyze	10

UNIT-IV
QUEUING THEORY

Part – A (Short Answer Questions)

1	Explain queue discipline	Analyze	11
2	Define Balking.	Remember	11

3	Calculate traffic intensity if inter arrival time is 125 minutes and inter service time is 10 minutes.	Evaluate	11
4	If average number of arrivals is 4 per hour and average number of services is 6 per hour. What is the probability that a new arrival need not wait for the service.	Understand	11
5	If $\lambda = 8$ and $\mu = 12$ per hour. Calculate the average time spent by a customer in the system	Apply	11
6	What is the probability that there are more than or equal to 10 customers in the system.	Understand	11
7	Explain pure birth process	Analyze	11
8	Explain pure death process	Analyze	11
9	Derive expected number of customers	Evaluate	11
10	Derive average waiting time in queue	Evaluate	12
11	If $\lambda = 6$ and $\mu = 18$ per hour. Calculate the service time.	Evaluate	12
12	Define transient state and steady sate	Remember	12
13	Explain M/M/1 model	Analyze	12
14	Explain M/M/1 with infinite population	Analyze	12
15	Derive probability of having n customers P(n) in a queue M/M/1, having Poisson arrival	Evaluate	12
Part – B (Long Answer Questions)			
1	Consider a box office ticket window being managed by a single server. Customer arrive to purchase ticket according to Poisson input process with a mean rate of 30 per hour. The time required to serve a customer has an exponential distribution with a mean of 910 sec. Determine the following: a)Fraction of the time the server is busy b)The average number of customers queuing for service	Apply	11
2	Patients arrive at a clinic in a Poisson manner at an average rate of 6 per hour. The doctor on average can attend to 8 patients per hour. Assuming that the service time distribution is exponential, find Average number of patients waiting in the queue, Average time spent by a patient in the clinic	Evaluate	12
3	A bank plans to open a single server drive in banking facilities at a particular centre. It is estimated that 20 customers will arrive each hour on an average. If on an average, it required 2 minutes to process a customers transaction, determine 1.The proportion of time that the system will be idle 2.On the average how long a customer will have to wait before reaching the server? 3. Traffic intensity of Bank? 4.The fraction of customers who will have to wait	Analyze	12
4	A car park contains five cars .The arrival of cars in Poisson with a mean rate of 10 per/hour. The length of time each car spends in the car park has negative exponential distribution with mean of two hours. how many cars are in the car park on average and what is the probability of newly arriving costumer finding the car park full and having to park his car else where	Evaluate	12
5	Consider a self service store with one cashier. Assume Poisson arrivals and exponential service time. Suppose that 9 customers arrive on the average of every 5 minutes and the cashier can serve 19 in 5 minutes. Find (i) the average number of customers queuing for service. (ii)the probability of having more than 10 customers in the system. (iii) the probability that the customer has to queue for more than 2 minutes	Evaluate	12
6	A self service canteen employs one cashier at its counter. 8 customers arrive per every 10 minutes on an average. The cashier	Evaluate	12

	can serve on average one per minute. Assuming that the arrivals are Poisson and the service time distribution is exponential, determine: (i)the average number of customers in the system; (ii) the average queue length; (iii) average time a customer spends in the system; (iv) average waiting time of each customer		
7	Customers arrive at a one window drive in bank according to a Poisson distribution with mean 10 per hour. Service time per customer is exponential with mean 5 minutes The car space in front of the window including that for the serviced can accommodate a maximum of 3 cars. Other cars can wait outside the space. i) What is the probability that an arriving customer can drive directly to the space in front of the window? Ii) What is the probability that an arriving customer will have to wait outside the indicated space? Iii) How long is an arriving customer expected to wait before starting service	Apply	12
8	A fast food restaurant has one drive window. Cars arrive according to a Poisson process. Cars arrive at the rate of 2 per 5 minutes. The service time per customer is 1.5 minutes. Determine i) The Expected number of customers waiting to be served. ii) The probability that the waiting line exceeds 10iii) Average waiting time until a customer reaches the window to place an order. iv) The probability that the facility is idle	Apply	12
9	At a railway station, only one train is handled at a time. The railway yard is sufficient only for two trains to wait while other is given signal to leave the station. Trains arrive at an average rate of 6 per hour and the railway station can handle them on an average of 12 per hour. Assuming Poisson arrivals and exponential service distribution, find the steady state probabilities for the various number of trains in the system. Find also the average waiting time of a new train coming into the yard	Apply	12
10	Consider a single server queuing system with Poisson input and exponential service time. Suppose the mean rate is 3 calling units per hour with the expected service time as 0.25 hours and the maximum permissible number of calling units in the system is two. Obtain the steady state probability distribution of the number of calling units in the system and then calculate the expected number in the system	Apply	12
Part – C (Problem Solving and Critical Thinking)			
1	What is probability of arrivals during the service time of any given customer?	Analyze	11
2	What is FIFO means?	Remember	11
3	Define Jack eying.	Understand	11
4	Define reneging.	Understand	11
5	Define m/m/1:FIFO	Understand	11
6	Model of queuing system.	Analyze	11
7	Define balking.	Understand	10
8	What is the pattern according to which customers are served?	Analyze	11
9	What is variance of queue length?	Analyze	11
10	How to calculate the idle time of the server according to queue theory	Evaluate	10
UNIT-V STOCHASTIC PROCESSES			
Part - A (Short Answer Questions)			
1	Define stochastic process	Remember	13
2	Define a regular Markov chain	Remember	13

3	Find whether the matrix $\begin{bmatrix} 0.75 & 0.25 & 0 \\ 0 & 0.5 & 0.5 \\ 0.6 & 0.4 & 0 \end{bmatrix}$ is a regular transition matrix or not.	Evaluate	13
4	Find periodic and aperiodic states in each of following transition probability matrices. (i) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ (ii) $\begin{bmatrix} \frac{1}{4} & \frac{3}{4} \\ \frac{1}{2} & \frac{1}{2} \end{bmatrix}$	Evaluate	13
5	Define reducible and non-reducible states.	Remember	13
6	Consider the Markov chain with transition probability matrix $\begin{bmatrix} 0 & 0 & 1 & 0 \\ 0.3 & 0.7 & 0 & 0 \\ 0.2 & 0.4 & 0.1 & 0.3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ is this matrix irreducible?	Analyze	13
7	Explain different types of stochastic process	Analyze	13
8	Give examples of stochastic process	Create	13
9	Find the expected duration of the game for double stakes	Evaluate	13
10	Define Markov's chain	Understand	13
11	Explain Markov's property	Understand	13
12	Explain transition probabilities	Understand	13
13	Explain stationary distribution	Understand	13
14	Explain limiting distribution	Understand	13
15	Explain irreducible and reducible	Understand	13
Part - B (Long Answer Questions)			
1	The transition probability matrix is given by $P = \begin{bmatrix} 0.1 & 0.4 & 0.5 \\ 0.2 & 0.2 & 0.6 \\ 0.7 & 0.2 & 0.1 \end{bmatrix}$ and $P_0 = [0.4 \quad 0.4 \quad 0.2]$ (a) Find the distribution after three transitions. (b) Find the limiting probabilities.	Evaluate	13
2	If the transition probability matrix of market shares of three brands A,B, and C is $\begin{bmatrix} 0.4 & 0.3 & 0.3 \\ 0.8 & 0.1 & 0.1 \\ 0.35 & 0.25 & 0.4 \end{bmatrix}$ and the initial market shares are 50%,25% and 25%, Find (a) The market shares in second and third periods (b) The limiting probabilities.	Evaluate	13
3	Define the stochastic matrixes which of the following stochastic matrices are regular. (a) $\begin{bmatrix} 1/2 & 1/4 & 1/4 \\ 0 & 1 & 0 \\ 1/2 & 0 & 1/2 \end{bmatrix}$ (b) $\begin{bmatrix} 2 & 1/2 & 0 \\ 1/2 & 1/2 & 0 \\ 1/4 & 1/4 & 1/2 \end{bmatrix}$	Remember & Evaluate	13
4	Three boys A, B, C are throwing a ball to each other. A always throws the ball to B; B always throws the ball to C; but C is just as likely to throw the ball to B as to A. Show that the process is Markovian. Find the transition matrix and classify the states. Do all the states are ergodic	Understand & Apply	13
5	A gambler has Rs.2. He bets Rs.1 at a time and wins Rs.1 with probability 0.5. He stops Playing if he loses Rs.2 or wins Rs.4.i)What is the Transition probability matrix of the related markov chain? (b) What is the probability that he has lost his money at the end of 5	Understand & Apply	14

	plays		
6	Check whether the following markov chain is regular and ergodic? $\begin{bmatrix} 1 & 1/2 & 1/2 & 0 \\ 1/2 & 0 & 0 & 1/2 \\ 1/2 & 0 & 0 & 1/2 \\ 0 & 1/2 & 1/2 & 1/2 \end{bmatrix}$	Apply	13
7	The transition probability matrix of a marker chain is given by $\begin{bmatrix} 0.3 & 0.7 & 0 \\ 0.1 & 0.4 & 0.5 \\ 0 & 0.2 & 0.8 \end{bmatrix}$ irreducibleor not?	Evaluate	13
8	. Which of the following matrices are Stochastic i) $\begin{bmatrix} 1/2 & 0 \\ 0 & 1 \end{bmatrix}$ ii) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ iii) $\begin{bmatrix} 1/2 & 1/4 & 1/4 \\ 1 & 1 & 0 \\ 1/2 & 1/2 & 0 \end{bmatrix}$	Apply	13
9	Which of the following Matrices are Regular i) $\begin{bmatrix} 1/2 & 1/2 \\ 0 & 1 \end{bmatrix}$ ii) $\begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$ iii) $\begin{bmatrix} 1/2 & 1/4 & 1/4 \\ 0 & 1 & 0 \\ 1/2 & 1/2 & 0 \end{bmatrix}$	Apply	13
10	a) Is the Matrix $\begin{bmatrix} 0.4 & 0.6 & 0 & 0 \\ 0.3 & 0.7 & 0 & 0 \\ 0.2 & 0.4 & 0.1 & 0.3 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ irreducible? (b) Is the Matrix p= $\begin{bmatrix} 0 & 1 & 0 \\ 1/2 & 1/6 & 1/3 \\ 1/3 & 2/3 & 0 \end{bmatrix}$ Stochastic?	Evaluate	13
Part – C (Problem Solving and Critical Thinking)			
1	What do you call the random variable in stochastic process?	Analyze	13
2	When the state is said to be Ergodic.	Analyze	13
3	What is null persistent state?	Understand	13
4	What is Markov process?	Understand	13
5	Give an example of discrete parameter Markov chain.	Create	13
6	When a matrix is said to be regular.	Understand	13
7	What is the use of Markov process?	Understand	13
8	When the state is said to be commute with each other.	Understand	13
9	Let $p = \frac{1}{2}, q = \frac{1}{2}, z = 500, a = 1000$ then find the expected duration of the game	Evaluate	14
10	If the stakes are doubled while the initial capital remain unchanged the probability ruin decreases for the player whose probability of success is P<1/2 and increases for the adversary	Apply	14

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