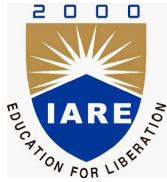


Hall Ticket No

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Question Paper Code: AHSB12



INSTITUTE OF AERONAUTICAL ENGINEERING (Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER-II

B.Tech III Semester End Examinations, November 2020

Regulations: IARE - R18

PROBABILITY AND STATISTICS (AERONAUTICAL & MECHANICAL)

Time: 3 hour

Maximum Marks: 70

Answer ONE Question from each MODULE

All Questions Carry Equal Marks

All parts of the question must be answered in one place only

MODULE-I

1. (a) Outline the concept of simulation of random variables. A random variable x has the following probability function:

| | | | | | | | | |
|------|---|---|----|----|----|-------|--------|----------|
| X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| P(X) | 0 | k | 2k | 2k | 3k | k^2 | $2k^2$ | $7k^2+k$ |

Calculate (i) k (ii) $P(x < 6)$ (iii) $P(x \geq 6)$ [7m]

- (b) Is the function defined by $f(x) = \begin{cases} 0 & x < 2 \\ \frac{1}{18}(2x + 3) & 2 \leq x \leq 4 \\ 0 & x \geq 4 \end{cases}$ a probability density function?

Estimate the probability that a variate having $f(x)$ as density function will fall in the interval $2 \leq x \leq 3$. [7m]

2. (a) If the probability that a communication system will have high fidelity is 0.81 and the probability that it will have selectivity and fidelity is 0.18. what is the probability that a system with high fidelity will also have high selectivity? [7m]

- (b) In a bolt factory machines A, B, C manufacture 20%, 30% and 50% of the total of their output and 6%, 3% and 2% are defective. A bolt is drawn at random and found to be defective. Calculate the probabilities that it is manufactured from (i) Machine A (ii) Machine B? [7m]

MODULE-II

3. (a) Out of 800 families with 5 children each, calculate how many would you expect to have (i) 3 boys (ii) 5girls (iii) either 2 or 3 boys .Assume equal probabilities for boys and girls. [7m]

- (b) A car-hire firm has two cars which it hires out day by day. The number of demands for a car on each day is distributed as a Poisson distribution with mean 1.5. Calculate the proportion of days (i) on which there is no demand (ii) on which demand is refused. [7m]
4. (a) Show that the Poisson distribution is a limiting case of Binomial distribution. [7m]
- (b) The life of electronic tubes of a certain type may be assumed to be normal distributed with mean 155 hours and standard deviation 19 hours. Calculate the probability that the life of a randomly chosen tube is [7m]
- (i) between 136 hours and 174 hours.
- (ii) less than 117 hours
- (iii) will be more than 195 hours.

MODULE-III

5. (a) Interpret the properties of rank correlation coefficient. A random sample of 5 college students is selected and their grades in mathematics and statistics are found to be

| | | | | | |
|-------------|----|----|----|----|----|
| | 1 | 2 | 3 | 4 | 5 |
| Mathematics | 85 | 60 | 73 | 40 | 90 |
| Statistics | 93 | 75 | 65 | 50 | 80 |

Calculate Spearman's rank correlation coefficient. [7m]

- (b) Explain the properties of Spearman's rank correlation coefficient. The heights of mothers and daughters are given in the following table. Calculate the Karl Pearsons coefficient of correlation for the following data. [7m]

| | | | | | | | | |
|--------------------------------|----|----|----|----|----|----|----|----|
| Height of the mother(inches) | 62 | 63 | 64 | 64 | 65 | 66 | 68 | 70 |
| Height of the daughter(inches) | 64 | 65 | 61 | 69 | 67 | 68 | 71 | 65 |

6. (a) Outline the formula of angle between two regression lines. If $\sigma_x = \sigma_y = \sigma$ and the angle between the regression lines are $\theta = \tan^{-1}(3)$, obtain r. [7m]
- (b) Outline the functions in R programming used for establishing linear regression. Calculate the most likely production corresponding to a rainfall 40 from the following data: [7m]

| | | |
|----------------------------|---------------|---------------|
| | Rain fall (X) | Production(Y) |
| Average | 30 | 500Kgs |
| Standard deviation | 5 | 100Kgs |
| Coefficient of correlation | 0.8 | |

MODULE-IV

7. (a) A random sample of size 100 is taken from an infinite population having the mean 76 and the variance 256. Estimate the probability that will be between 75 and 78. [7m]
- (b) A population consists of ranks of five students based on their performance in a physical test. If the population is 3, 6, 9, 15, 27. List all possible samples of size 3 that can be taken without replacement from the finite population.

- (i) Calculate the mean of each of the sampling distribution of means.
(ii) Calculate the standard deviation of sampling distribution of means. [7m]

8. (a) According to norms established for a mechanical aptitude test, the persons who are 18 years have an average weight of 73.2 with S.D 8.6 if 40 randomly selected persons have average 76.7. Examine the truth value of the hypothesis $H_0 : \mu = 73.2$ against alternative hypothesis : $\mu > 73.2$. [7m]
(b) Among the items produced by a factory out of 500, 15 were defective. In another sample of 400, 20 were defective. Examine whether there is any significant difference between two proportions at 5% level. [7m]

MODULE-V

9. (a) Producer of gutkha claims that the nicotine content in his gutkha on the average is 0.83mg. can This claim be accepted if a random sample of 8 gutkhas of This type have the nicotine contents of 2.0, 1.7, 2.1, 1.9, 2.2, 2.1, 2.0, 1.6mg. [7m]
(b) The measurements of the output of two units have given the following results. Assuming that both samples have been obtained from the normal populations at 10% significant level, examine whether the two populations have the same variance. [7m]

| | | | | | |
|----------|------|------|------|------|------|
| Unit- A | 14.1 | 10.1 | 14.7 | 13.7 | 14.0 |
| Unit - B | 14.0 | 14.5 | 13.7 | 12.7 | 14.1 |

10. (a) A mechanist making engine parts with axle diameters of 0.700 inch. A random sample of 10 parts shows a mean diameter of 0.742 inch with a S.D of 0.040 inch. Compute the statistic you would use to Examine whether the work is meeting the specifications. [7m]
(b) A survey of 240 families with 4 children each revealed the following distribution. Examine whether the male and female births are equally popular by selecting suitable probability distribution for computing expected frequencies. [7m]

| | | | | | |
|----------------|----|----|-----|----|----|
| Male Births | 4 | 3 | 2 | 1 | 0 |
| No of families | 10 | 55 | 105 | 58 | 12 |

****END OF EXAMINATION****

COURSE OBJECTIVES:

The course should enable the students to:

| | |
|---|---|
| 1 | The Principles of probability, the theory of random variables, basic random variate distributions and their applications. |
| 2 | The Methods and techniques for quantifying the degree of closeness among two or more variables and linear regression analysis. |
| 3 | The Estimation statistics and Hypothesis testing which play a vital role in the assessment of the quality of the materials, products and ensuring the standards of the engineering process. |
| 4 | The statistical tools which are essential for translating an engineering problem into probability model. |

COURSE OUTCOMES:

After successful completion of the course, students should be able to:

| | |
|-------|--|
| CO 1 | Determine the conditional probability of interdependent events by using Bayes theorem. |
| CO 2 | Explain simulation of random events by using the concept of random variables |
| CO 3 | Calculate the expected values, variances of the discrete and continuous random variables for making decisions under randomized probabilistic conditions. |
| CO 4 | Interpret the Probability distributions such as Binomial, Poisson and Normal distribution by using their probability functions and parameters. |
| CO 5 | Apply the concepts of discrete and continuous probability distribution and CLT for solving real time problems under probabilistic conditions. |
| CO 6 | Interpret the results of Bivariate and Multivariate Regression as well as Correlation Analysis for statistical forecasting. |
| CO 7 | Identify the role of types of statistical hypotheses, types of errors, sampling distributions of means and confidence intervals in hypothesis testing. |
| CO 8 | Apply tests of hypotheses for both large and small samples in making decisions over statistical claims. |
| CO 9 | Test for the assessment of goodness of fit of the given probability distribution model by using Chi-square distribution. |
| CO 10 | Make Use of R software package in computing confidence intervals, Regression analysis and hypothesis testing. |
| CO 11 | Select appropriate statistical methods for solving real-time engineering problems governed by laws of probability. |

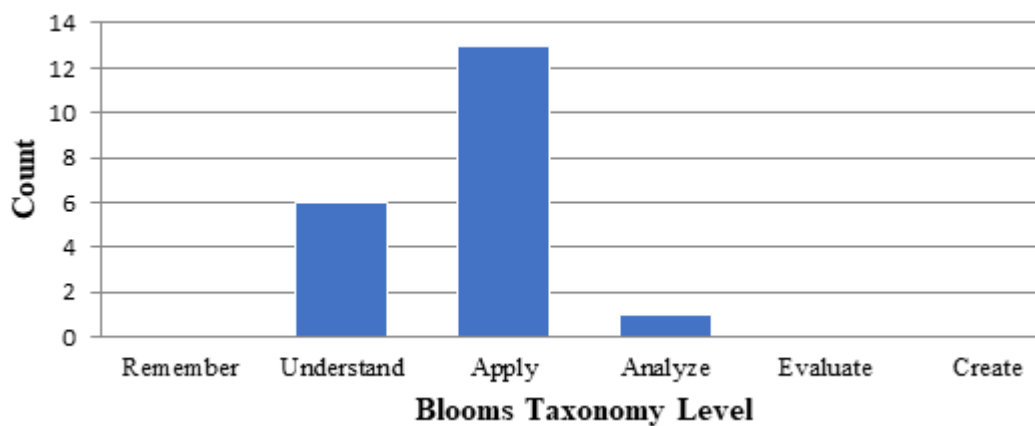
MAPPING OF SEMESTER END EXAMINATION QUESTIONS TO COURSE OUTCOMES

| Q.No | | All Questions carry equal marks | Taxonomy | CO's | PO's | | | | | | | | | | | | | | | | | | |
|------|---|--|------------|--------|--------|----------------|-----------------|--------------------|---|---|---|------|---|---|----|----|----|----------------|-----------------|--------------------|------------|------|------|
| 1 | a | Outline the concept of simulation of random variables. A random variable x has the following probability function: <table border="1" style="margin: 10px auto; border-collapse: collapse;"> <tr> <td>X</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> </tr> <tr> <td>P(X)</td> <td>0</td> <td>k</td> <td>2k</td> <td>2k</td> <td>3k</td> <td>k²</td> <td>2k²</td> <td>7k²+k</td> </tr> </table> Calculate (i) k (ii) $P(x < 6)$ (iii) $P(x \geq 6)$ | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | P(X) | 0 | k | 2k | 2k | 3k | k ² | 2k ² | 7k ² +k | Understand | CO 2 | PO 1 |
| | X | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | | | | | | | | | | | | |
| P(X) | 0 | k | 2k | 2k | 3k | k ² | 2k ² | 7k ² +k | | | | | | | | | | | | | | | |
| b | Is the function defined by $f(x) = \begin{cases} 0 & x < 2 \\ \frac{1}{18}(2x + 3) & 2 \leq x \leq 4 \\ 0 & x \geq 4 \end{cases}$ a probability density function? Estimate the probability that a variate having f(x) as density function will fall in the interval $2 \leq x \leq 3$. | Apply | CO 3 | PO 1,4 | | | | | | | | | | | | | | | | | | | |
| 2 | a | If the probability that a communication system will have high fidelity is 0.81 and the probability that it will have selectivity and fidelity is 0.18. what is the probability that a system with high fidelity will also have high selectivity? B? | Apply | CO 1 | PO 1,4 | | | | | | | | | | | | | | | | | | |
| | b | In a bolt factory machines A, B, C manufacture 20%, 30% and 50% of the total of their output and 6%, 3% and 2% are defective. A bolt is drawn at random and found to be defective. Calculate the probabilities that it is manufactured from (i) Machine A (ii) Machine | Apply | CO 1 | PO 1,4 | | | | | | | | | | | | | | | | | | |
| 3 | a | Out of 800 families with 5 children each, calculate how many would you expect to have (i) 3 boys (ii) 5girls (iii) either 2 or 3 boys . Assume equal probabilities for boys and girls. | Apply | CO 5 | PO 1,2 | | | | | | | | | | | | | | | | | | |
| | b | A car-hire firm has two cars which it hires out day by day. The number of demands for a car on each day is distributed as a Poisson distribution with mean 1.5. Calculate the proportion of days (i) on which there is no demand (ii) on which demand is refused. | Apply | CO 5 | PO 1,2 | | | | | | | | | | | | | | | | | | |
| 4 | a | Show that the Poisson distribution is a limiting case of Binomial distribution. | Understand | CO 4 | PO 1 | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------|---------------|--|------------|---------------|---------------|---------|----|--------|--------------------|----|--------|-------------------|-----|----|------------|-------|--------|----|----|----|------------|------|--------|
| | b | The life of electronic tubes of a certain type may be assumed to be normal distributed with mean 155 hours and standard deviation 19 hours. Calculate the probability that the life of a randomly chosen tube is (i) between 136 hours and 174 hours. (ii) less than 117 hours (iii) will be more than 195 hours. | Apply | CO 5 | PO 1,2 | | | | | | | | | | | | | | | | | | |
| 5 | a | Interpret the properties of rank correlation coefficient. A random sample of 5 college students is selected and their grades in mathematics and statistics are found to be <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> <tr> <td>Mathematics</td> <td>85</td> <td>60</td> <td>73</td> <td>40</td> <td>90</td> </tr> <tr> <td>Statistics</td> <td>93</td> <td>75</td> <td>65</td> <td>50</td> <td>80</td> </tr> </table> | | 1 | 2 | 3 | 4 | 5 | Mathematics | 85 | 60 | 73 | 40 | 90 | Statistics | 93 | 75 | 65 | 50 | 80 | Understand | CO 6 | PO 1,4 |
| | 1 | 2 | 3 | 4 | 5 | | | | | | | | | | | | | | | | | | |
| Mathematics | 85 | 60 | 73 | 40 | 90 | | | | | | | | | | | | | | | | | | |
| Statistics | 93 | 75 | 65 | 50 | 80 | | | | | | | | | | | | | | | | | | |
| | b | Explain the properties of Spearman's rank correlation coefficient. The heights of mothers and daughters are given in the following table. Calculate the Karl Pearsons coefficient of correlation for the following data Height (inches). <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>mother</td> <td>62</td> <td>63</td> <td>64</td> <td>64</td> <td>65</td> <td>66</td> <td>68</td> <td>70</td> </tr> <tr> <td>daughter</td> <td>64</td> <td>65</td> <td>61</td> <td>69</td> <td>67</td> <td>68</td> <td>71</td> <td>65</td> </tr> </table> | mother | 62 | 63 | 64 | 64 | 65 | 66 | 68 | 70 | daughter | 64 | 65 | 61 | 69 | 67 | 68 | 71 | 65 | Understand | CO 6 | PO 1,4 |
| mother | 62 | 63 | 64 | 64 | 65 | 66 | 68 | 70 | | | | | | | | | | | | | | | |
| daughter | 64 | 65 | 61 | 69 | 67 | 68 | 71 | 65 | | | | | | | | | | | | | | | |
| 6 | a | Outline the formula of angle between two regression lines. If $\sigma_x = \sigma_y = \sigma$ and the angle between the regression lines are $\theta = \tan^{-1}(3)$, obtain r. | Understand | CO 6 | PO 1,4 | | | | | | | | | | | | | | | | | | |
| | b | Outline the functions in R programming used for establishing linear regression. Calculate the most likely production corresponding to a rainfall 40 from the following data: <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td> <td>Rain fall (X)</td> <td>Production(Y)</td> </tr> <tr> <td>Average</td> <td>30</td> <td>500Kgs</td> </tr> <tr> <td>Standard deviation</td> <td>5</td> <td>100Kgs</td> </tr> <tr> <td>Coeff correlation</td> <td>0.8</td> <td></td> </tr> </table> | | Rain fall (X) | Production(Y) | Average | 30 | 500Kgs | Standard deviation | 5 | 100Kgs | Coeff correlation | 0.8 | | Apply | CO 10 | PO 1,4 | | | | | | |
| | Rain fall (X) | Production(Y) | | | | | | | | | | | | | | | | | | | | | |
| Average | 30 | 500Kgs | | | | | | | | | | | | | | | | | | | | | |
| Standard deviation | 5 | 100Kgs | | | | | | | | | | | | | | | | | | | | | |
| Coeff correlation | 0.8 | | | | | | | | | | | | | | | | | | | | | | |
| 7 | a | A random sample of size 100 is taken from an infinite population having the mean 76 and the variance 256. Estimate the probability that will be between 75 and 78. | Apply | CO 5 | PO 1,2 | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | |
|----------------|------|--|-------------|-------|--------|------|------|------|----------------|------|------|------|------|------|---------|-------|
| | b | A population consists of ranks of five students based on their performance in a physical test. If the population is 3, 6, 9, 15, 27. List all possible samples of size 3 that can be taken without replacement from the finite population. (i) Calculate the mean of each of the sampling distribution of means. (ii) Calculate the standard deviation of sampling distribution of means. | Understand | CO 7 | PO 1 | | | | | | | | | | | |
| 8 | a | According to norms established for a mechanical aptitude test, the persons who are 18 years have an average weight of 73.2 with S.D 8.6 if 40 randomly selected persons have average 76.7 Examine the truth value of the hypothesis $H_0 : \mu = 73.2$ against alternative hypothesis : $\mu > 73.2$ | Apply | CO 8 | PO 1,2 | | | | | | | | | | | |
| | b | Among the items produced by a factory out of 500, 15 were defective. In another sample of 400, 20 were defective Examine whether there is any significant difference between two proportions at 5% level. | Apply | CO 8 | PO 1,2 | | | | | | | | | | | |
| 9 | a | Producer of gutkha claims that the nicotine content in his gutkha on the average is 0.83mg. can This claim be accepted if a random sample of 8 gutkhas of This type have the nicotine contents of 2.0, 1.7, 2.1, 1.9, 2.2, 2.1, 2.0, 1.6mg. | Apply | CO 8 | PO 1,2 | | | | | | | | | | | |
| | b | The measurements of the output of two units have given the following results. Assuming that both samples have been obtained from the normal populations at 10% significant level, examine whether the two populations have the same variance. <table border="1"> <tr> <td>Unit- A</td> <td>14.1</td> <td>10.1</td> <td>14.7</td> <td>13.7</td> <td>14.0</td> </tr> <tr> <td>Unit - B</td> <td>14.0</td> <td>14.5</td> <td>13.7</td> <td>12.7</td> <td>14.1</td> </tr> </table> | Unit- A | 14.1 | 10.1 | 14.7 | 13.7 | 14.0 | Unit - B | 14.0 | 14.5 | 13.7 | 12.7 | 14.1 | Apply | CO 10 |
| Unit- A | 14.1 | 10.1 | 14.7 | 13.7 | 14.0 | | | | | | | | | | | |
| Unit - B | 14.0 | 14.5 | 13.7 | 12.7 | 14.1 | | | | | | | | | | | |
| 10 | a | A mechanist making engine parts with axle diameters of 0.700 inch. A random sample of 10 parts shows a mean diameter of 0.742 inch with a S.D of 0.040 inch. Compute the statistic you would use to Examine whether the work is meeting the specifications. | Apply | CO 11 | PO 1 | | | | | | | | | | | |
| | b | A survey of 240 families with 4 children each revealed the following distribution.Examine whether the male and female births are equally popular by selecting suitable probability distribution for computing expected frequencies. <table border="1"> <tr> <td>Male Births</td> <td>4</td> <td>3</td> <td>2</td> <td>1</td> <td>0</td> </tr> <tr> <td>No of families</td> <td>10</td> <td>55</td> <td>105</td> <td>58</td> <td>12</td> </tr> </table> | Male Births | 4 | 3 | 2 | 1 | 0 | No of families | 10 | 55 | 105 | 58 | 12 | Analyze | CO 9 |
| Male Births | 4 | 3 | 2 | 1 | 0 | | | | | | | | | | | |
| No of families | 10 | 55 | 105 | 58 | 12 | | | | | | | | | | | |

KNOWLEDGE COMPETENCY LEVELS OF MODEL QUESTION PAPER



Signature of Course Coordinator

HOD, Freshmen Dept
Freshmen Dept