MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

SECOND YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECU 201: ENGINEERING MATHEMATICS VI

DATE: 14TH JANUARY, 2025 **TIME: 8.30 AM – 10.30 AM**

INSTRUCTIONS:

*Answer question **ONE (Compulsory)** and **any other TWO** questions*

QUESTION ONE (30 MARKS)

a) The diameter of a steel pipe used in construction is assumed to be a continuous random variable with probability density function;

$$f(x) = \begin{cases} kx(1-x^2), & 0 < x < 1 \\ o, & elsewhere \end{cases}$$, find the value of k and mean of x. (5marks)

(b) A construction company receives an average of four inquiries per week. Determine the probability that the number of enquiries in a week will be exactly 2 (3marks)

c) A discrete random variable x has a probability function given by:

x	0	1	2	3	4	5
$f(x)$	0.10	0.15	$2k$	0.25	k	0.05

(i) Find the value of k (2marks)

(ii) Determine the probability that x is at least 3. (1mark)

d) A binomial random variable has $\mu = 50$ and S.D =5, find the values of n and p (2marks)

e) An artist has 5 green, 7 blue and 3 red crayons of the same size in a bag. If he picks two crayons at random from the bag without replacement, find the probability that

i. No red is picked. (3marks)
ii. The two are of the same color. (3marks)
iii. A blue and green in that order (2marks)

f) From the frequency distribution below, draw an ogive and estimate the median. (5marks)

Diameter(mm)	10-12	13-15	16-18	19-21	22-24	25-27
Frequency(f)	2	7	12	5	3	1

h) The data below are the number of seeds germinated out of five planted seeds in each of the 50 pots.

No. of seeds germinated (X)	1	2	3	4	5
No. of pots (f)	8	16	14	9	3

Find the geometric mean of the number of seeds germinated. (4 marks)

QUESTION TWO (20 MARKS)

a) Given that $f(x) = \begin{cases} e^{-x}\,0, & x > 0 \\ o, & elsewhere \end{cases}$ find the moment generating function and use it to find the mean (5marks)

b) Two dice are thrown. What is the probability that the absolute difference of the two faces is at most 2 (5marks)

c) The table shows marks scored by 80 students in an examination. If the modal mark is 52, determine the values of x and y. (5marks)

marks	0-20	20-40	40-60	60-80	80-100
No. of students	17	x	20	y	8

d) Given the frequency distribution below, find; 1st quartile and the 5th Decile. (5marks)

marks	10-15	15-20	20-25	25-30	30-35	35-40

Frequency(f)	20	15	31	22	10	2

QUESTION THREE (20 MARKS)

a) A 3-hour examination is given to all prospective sales people of a national retail chain. The time "x' in hours taken to complete the examination has been found to be a random variable with a density function;

$$f(x) = \begin{cases} \frac{10x-x^2}{36} & :0 \le x \le 3 \\ 0 \quad , & elsewhere \end{cases}$$

Determine:

i. The probability that someone will complete the exam in one hour or less.

ii. The variance of the distribution hence the standard deviation. (11marks)

b) Usually, 12% of the items produced by a firm are defective. A quality assurance analyst selects a random sample of 8 items from a day's production in this firm.

Determine;

i. The expected number of defective items in the selected sample.

ii. The probability that out of the selected items, none is defective.

iii. The probability that out of the selected items, between 3 and 5 are defective. (9marks)

QUESTION FOUR (20 MARKS)

a) Suppose that the weight of navel orange is normally distributed with mean, $\mu = 8kg$ and standard deviation, $\sigma = 1.5kg$,

(i) What proportion of oranges weigh between 6.8 and 8.9kgs? (4marks)

(ii) What proportion of oranges weigh greater than 9kgs? (4marks)

b) The marks scored in ECU 210 by students who sat for the examination in a certain year has been found to be normally distributed with mean 54 marks and a standard deviation 12 marks.

i. Determine the proportion of the students who passed if the pass-mark was set at 45 marks. (4marks)

ii. Determine the proportion of the students who scored a credit grade if a credit is assigned for marks between 60 and 74. (4marks)

iii. If the top 65% of the students are supposed to pass the examination, determine the mark which should be set as the pass-mark to achieve this. (4marks)

QUESTION FIVE (20 MARKS)

a) A structural engineer is asked to grade a junior college trainee.in order to ensure that he treats the trainee fairly, the engineer repeats the grading. The results are tabulated below;

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**
1st grading	55	53	78	50	48	61	66	76	85	90	69	45
2nd grading	75	80	89	63	67	69	73	93	87	95	92	59

Use spearman's rank correlation to determine if the two grading are consistent. (10marks)

b) The data given in table below shows temperatures and the time it takes for a concrete mixture to dry up.

Temp	15	16	18	22	14	25	17	28	30	26
Time	21	20	18	16	24	15	18	14	12	14

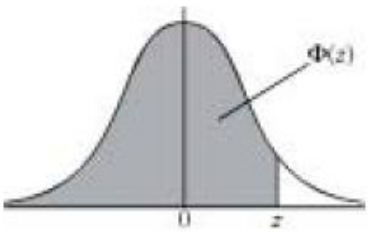
Compute the Pearson's product moment correlation coefficient 'r' and hence comment on the relationship between temperature and the time it takes for the mixture to dry. (10marks)

THE NORMAL DISTRIBUTION FUNCTION

If Z has a normal distribution with mean 0 and variance 1 then, for each value of z, the table gives the value of $\Phi(z)$, where

$$\Phi(z) = \mathrm{P}(Z \le z).$$

For negative values of z use $\Phi(-z) = 1 - \Phi(z)$.



z	0	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
											ADD								
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359	4	8	12	16	20	24	28	32	36
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753	4	8	12	16	20	24	28	32	36
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141	4	8	12	15	19	23	27	31	35
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517	4	7	11	15	19	22	26	30	34
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879	4	7	11	14	18	22	25	29	32
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224	3	7	10	14	17	20	24	27	31
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549	3	7	10	13	16	19	23	26	29
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852	3	6	9	12	15	18	21	24	27
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133	3	5	8	11	14	16	19	22	25
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389	3	5	8	10	13	15	18	20	23
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621	2	5	7	9	12	14	16	19	21
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830	2	4	6	8	10	12	14	16	18
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015	2	4	6	7	9	11	13	15	17
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177	2	3	5	6	8	10	11	13	14
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319	1	3	4	6	7	8	10	11	13
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441	1	2	4	5	6	7	8	10	11
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545	1	2	3	4	5	6	7	8	9
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633	1	2	3	4	4	5	6	7	8
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706	1	1	2	3	4	4	5	6	6
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767	1	1	2	2	3	4	4	5	5
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817	0	1	1	2	2	3	3	4	4
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857	0	1	1	2	2	2	3	3	4
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890	0	1	1	1	2	2	2	3	3
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916	0	1	1	1	1	2	2	2	2
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936	0	0	1	1	1	1	1	2	2
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952	0	0	0	1	1	1	1	1	1
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964	0	0	0	0	1	1	1	1	1
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974	0	0	0	0	0	1	1	1	1
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981	0	0	0	0	0	0	0	1	1
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986	0	0	0	0	0	0	0	0	0