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CINEC Campus

Faculty of Engineering & Technology

Bachelor of Science Honours in Engineering

CE2325 Soil Mechanics and Engineering Geology I

FINAL EXAMINATION PAPER – Semester 4

Date	:	**11th July 2025**
Examiners	:	**Gavithra Udayakumara**
Time Allowed:	:	**3 Hours**

INSTRUCTIONS TO CANDIDATES

- This is a Closed book examination.
- This question paper consists of **four** questions.
- Answer **all four** questions.
- Show all stages of your work, with diagrams where appropriate.
- You may use a scientific calculator. This must not be programmable, and may be inspected during the examination.
- Write legibly in blue or black ink.
- Graph papers are required for this exam
- Check your work carefully for inaccurate spelling, punctuation and grammar.
- You may not leave the examination room during the first hour or last 30 minutes of the exam.
- An announcement will be made when there are 30 minutes of the exam time left.

Question 01

a) The results of a sieve analysis on a soil sample were: Total mass of the soil sample was 311g)

Sieve size (mm)	Mass retained (g)
50	0.0
37.5	15.5
20	17
14	10
10	11
6.3	33
3.35	114.5
1.18	63.3
0.6	18.2
0.15	17
0.063	10.5

I. Plot the particle size distribution curve **(10 marks)**

II. Determine sand, gravel and fine fractions **(3 marks)**

III. Determine the coefficient of uniformity (C_u) and coefficient of curvature (C_c) of the soil. **(4 marks)**

IV. Determine whether the soil is well graded or poorly graded based on C_c and C_u values **(3 marks)**

b) The liquid and plastic limit tests gave the following results

	Liquid limit test				Plastic limit Test	
	Test 01	Test 02	Test 03	Test 04	Test 01	Test 02
Container +Wet soil (g)	33.20	32.10	28.20	31.00	11.83	15.04

Container +Dry soil (g)	28.20	26.50	22.40	23.90	11.25	14.07
Container (g)	7.02	7.04	7.10	7.02	7.04	7.25
No of blows	23	27	31	34	–	–

i. Determine the Liquid limit, Plastic Limit and plasticity index of the soil **(5 marks)**

ii. Comment on the plasticity of the soil using above indices **(3 marks)**

iii. Classify the soil using Unified soil classification system **(2 marks)**

Question 02

a) Explain, what is the importance of drawing zero air void curve with the laboratory compaction curve? (4 marks)

b) The results of a laboratory proctor compaction test results for a clayey silt is shown below ($g = 9.81 ms^{-2}$)

Table 1

Moisture content%	Bulk unit weight (kN/m^3)
6	15.69
8	18.79
9	20.17
11	20.98
12	20.72
14	19.27

Following are the results obtained from a field unit-weight determination test performed on the same soil by means of the sand cone method:

Calibrated dry density of Ottawa sand = 1570 kg/m^3
Calibrated mass of Ottawa sand to fill the cone = 0.545 kg
Mass of jar + cone + sand (before use) = 7.59 kg
Mass of jar + cone + sand (after use) = 4.78 kg
Mass of moist soil from hole = 3.007 kg
Moisture content of moist soil = 10.2%

Determine:

I. Field Dry unit weight. **(8marks)**
II. Draw compaction curve and find the maximum laboratory dry unit weight. **(10marks)**
III. Relative compaction in the field **(2marks)**

c) As the first stage of the site investigation programme, you are required to perform a desk study. List main sources that you are going to refer during your desk study. **(5marks).**

Question 3

a) Describe the three main types of soils based on formation: transported, residual, and organic. Explain how each type form **(3 marks)**
b) Illustrate the rock cycle. **(3 marks)**
c) Identify main rock types and give at least 3 examples for each **(3 marks)**
d) A drainage pipe (Figure 2) became completely blocked during a storm by a plug of sand 1.5 m long, followed by another plug of a mixture of clays, silts, and sands 0.5 m long. When the storm was over, the water level above ground was 1 m. The hydraulic conductivity of the sand is 2 times that of the mixture of clays, silts, and sands.

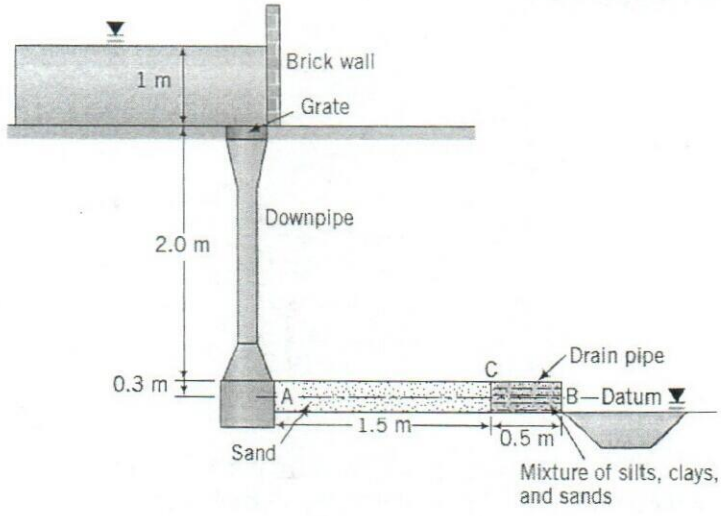


Figure 2

I. Find the total heads at A and B. **(3 marks)**

II. Suppose that the head loss at sand plug and mixed soil plug is H1 & H2 respectively. Write down equations for the flow of water through the two soil plugs separately, based on Darcy's equation and find the ratio of H1/H2. (**4 marks**)

III. Determine Total head at C. (**2 marks**)

IV. Calculate the average equivalent permeability along horizontal direction among the two soil plugs. (**2 marks**)

Question 04

a) A 9m thick layer of sandy silt soil overlies an impermeable bedrock. The initial Groundwater level is at a depth of 2m below the ground surface. Water was pumped out of the soil from a central well at the rate of 400 m^3/hr. Two observation wells were setup on a radial line from the center of the main well at distances of 2m and 15m and the top of each well located at same elevation. During pumping the water level in the well nearest to the pump was 3.8 m below ground level and in the furthest well was 2.1m below ground level. Determine an average value for the permeability of the soil in m/s **(8 marks)**

b) An undisturbed soil sample was tested in a falling head permeameter. The result were:

Initial head of water in stand pipe	= 1500 mm
Final head of water in stand pipe	= 605 mm
Duration of test	= 281 s
Sample length	= 150 mm
Sample diameter	= 100 mm
Stand-pipe diameter	= 5 mm

Determine the permeability of the soil in m/s. (7 marks)

c) Permeability is a key parameter in geotechnical engineering. Discuss the importance of constant head and falling head permeability tests, highlighting their procedures, applicability to different soil type (5 Marks)

- End of question paper -

Additional Information

$$G_s = \frac{W_s}{V_s\gamma_w} = \frac{M_s}{V_s\rho_w}$$

$$\rho_b = \rho_w \frac{(G_s + eS_r)}{1+e}$$

$$\rho_d = \frac{\rho_w G_s}{1+e} = \frac{\rho_b}{1+w}$$

$$\rho_{sat} = \rho_w \frac{(G_s + e)}{1+e}$$

$$\rho' = \rho_w \frac{(G_s - 1)}{1+e}$$

$$\gamma_b = \gamma_w \frac{(G_s + eS_r)}{1+e}$$

$$w = \frac{W_w}{W_s} = \frac{M_w}{M_s}$$

$$e = \frac{V_v}{V_s}$$

$$e = wG_s \quad \text{(saturated)}$$

$$e = \frac{wG_s}{S_r} \quad \text{(partially saturated)}$$

$$n = \frac{V_v}{V} = \frac{e}{1+e}$$

$$S_r = \frac{V_w}{V_v}$$

$$\gamma_d = \frac{\gamma_w G_s}{1+e} = \frac{\gamma_b}{1+w}$$

$$\gamma_{sat} = \gamma_w \frac{(G_s + e)}{1+e}$$

$$\gamma' = \gamma_w \frac{(G_s - 1)}{1+e}$$

$$I_D = \frac{e_{max} - e}{e_{max} - e_{min}}$$

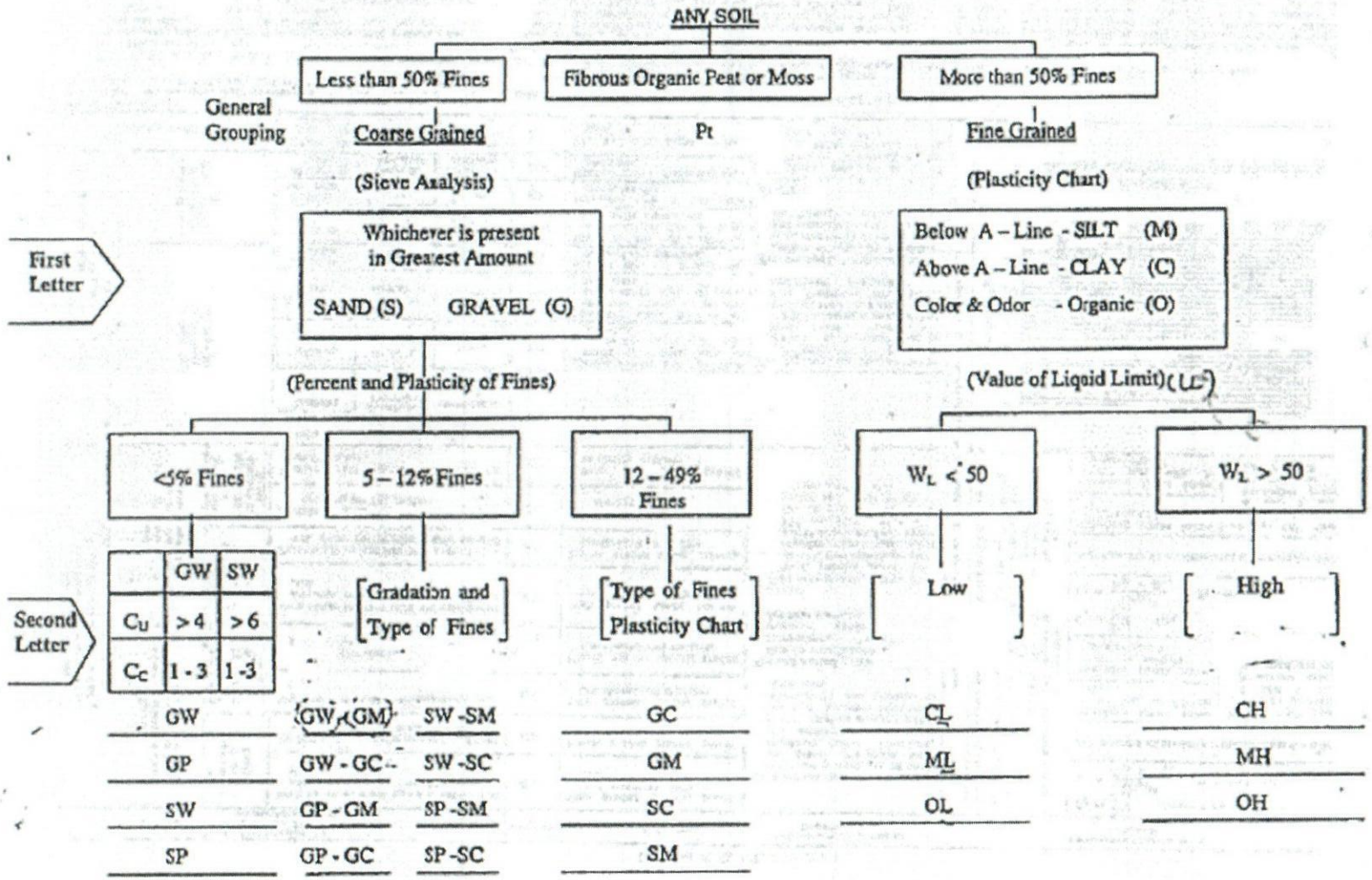
$$k_z = \frac{H}{\frac{H_1}{k_1} + \frac{H_2}{k_2} + \frac{H_3}{k_3} + \cdots + \frac{H_n}{k_n}}$$

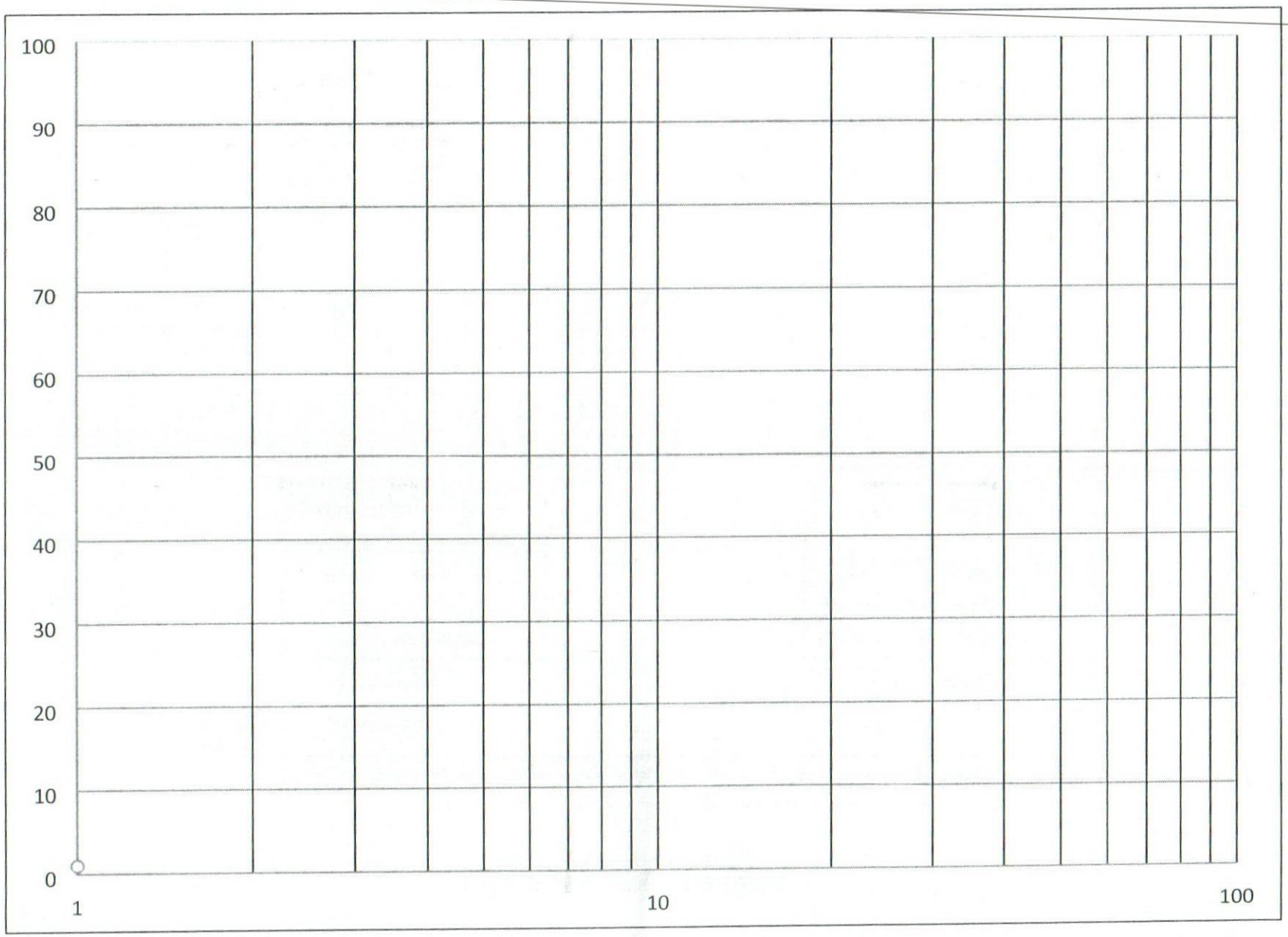
$$k = \frac{q \ln r_2/r_1}{\pi(h_2^2 - h_1^2)}$$

$$k_x = \frac{H_1k_1 + H_2k_2 + H_3k_3 + \cdots + H_nk_n}{H}$$

$$k = \frac{aL}{At} \ln \frac{h_1}{h_2} \qquad k = \frac{QL}{tAh}$$

UNIFIED SOIL CLASSIFICATION SYSTEM
CLASSIFICATION PROCEDURE





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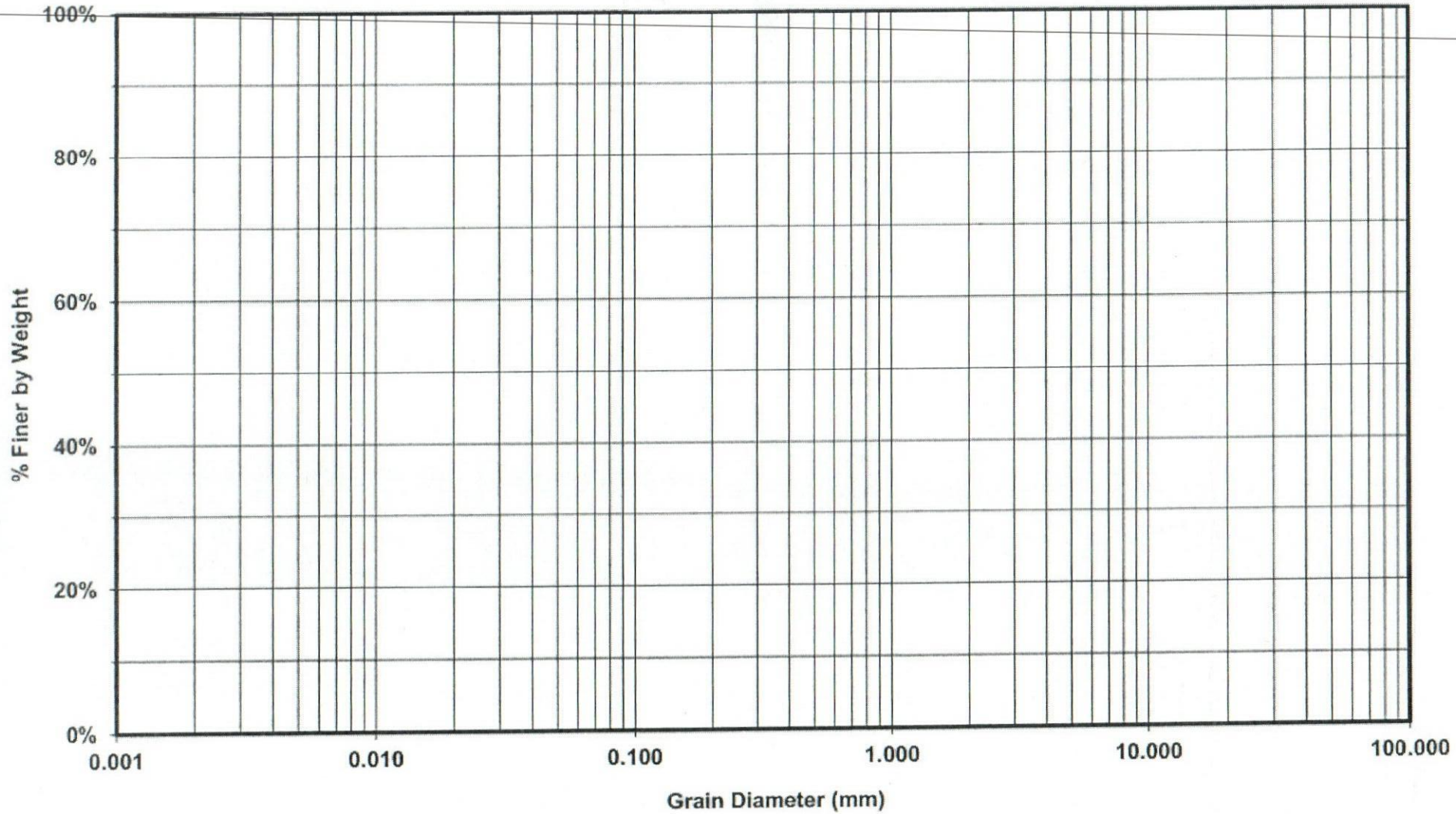

100%
80%
60%
40%
20%
0%
% Finer by Weight
0.001
0.010
0.100
1.000
10.000
100.000
Grain Diameter (mm)

CINEC CAMPUS
Beyond A Graduate

FACULTY OF ENGINEERING & TECHNOLOGY

BACHELOR OF SCIENCE HONOURS IN ENGINEERING

FINAL EXAMINATION

Module Code	:	**FE2321**
Module Title	:	**Engineering Mathematics IV**
Academic Year	:	**2025**
Date	:	**07th July 2025**
Examiner	:	**Dr. Shelton Perera**
Time Allowed	:	**3 Hours**

INSTRUCTIONS TO CANDIDATES

- This is a closed book examination.
- You should answer all four questions. Each question carries equal marks.
- Each answer should start on a separate page.
- This paper contains 9 pages
- Additional information is provided on pages 5-9.

MATERIALS REQUIRED

- Two eight-page answer booklets
- You may use a Scientific calculator. This must not be programmable and may be inspected during the examination.

Student Number .....

1.

i) Let $f(x,y,z) = 3x^2y + 2y^2z + z^2x$. Find the magnitude of the greatest rate of change of f at $(1,-1,1)$. (15 Marks)

ii) Consider the vector field $\boldsymbol{F} = (3x^2 + yz)\boldsymbol{i} + (xz + 2y)\boldsymbol{j} + (xy + 4z)\boldsymbol{k}$.
a) Show that $\boldsymbol{F}$ is irrotational. (15 Marks)
b) Find the divergence of $\boldsymbol{F}$ in general terms and at (1, 1, 1). (10 Marks)

iii) Let $f(x,y) = 3x^2 - 4xy + 2y^2 + 6x - 8y$.
a) Find $f_x(x,y)$, $f_y(x,y)$, $f_{xx}(x,y)$, $f_{yy}(x,y)$, and $f_{xy}(x,y)$. (10 Marks)
b) Find and classify the stationary point of f. (20 Marks)

iv) A rectangular storage container with an open top must have a volume of 62.5 cubic meters. Find the dimensions of the box that minimize the surface area. (30 Marks)

2.

i) Evaluate $\int_0^1 \int_0^y (3x^2\,y - 2e^y)\,dxdy$. (25 Marks)

ii) Let V be the tetrahedron bounded by the planes $x = 0, y = 0, z = 0$ and $x + y + z = 1$. Find the value of $\iiint_V y\,dV$. (35 Marks)

iii) Let R be the region bounded by the lines $x + y = 1, x - y = 1$, $x+y = -1$ and $x - y = -1$. Evaluate $\iint_R (x + y)^2\,dA$. (40 Mar

3.

i) Let $\boldsymbol{F} = (2xy + z^2)\boldsymbol{i} + (x^2 + 3y^2)\boldsymbol{j} + (2xz + 2z)\boldsymbol{k}$.
Also, let C be the curve from $O = (0,0,0)$ to $A = (1,1,1)$ given by

$$C: \quad x = t, \qquad y = t^2, \qquad z = t^3 \ \ (0 \le t \le 1).$$

a) Find $\int_C \boldsymbol{F}.\boldsymbol{dr}$. (20 Marks)

b) Show that $\boldsymbol{F}$ is a conservative vector field. (10 Marks)

c) Find a scalar field φ such that grad φ=$\boldsymbol{F}$. (18 Marks)

d) Find $\int_{C_1} \boldsymbol{F}.\boldsymbol{dr}$, where C_1 is any path from (1,0,0) to (0,1,1). (7 Marks)

ii) Let $f(t) = \begin{cases} 0, & -2 < t < 0 \\ 2, & 0 < t < 2 \end{cases}$ $\qquad f(t+4) = f(t)$

a) Sketch a graph of $f(t)$ in the interval $-4 < t < 4$ (5 Marks)

b) Find the Fourier series representation of $f(t)$ (30 Marks)

c) Use the series to obtain the identity : (10 Marks)

$$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots$$

4.

i) Let X be a continuous random variable with the probability density function given by

$$f(x) = \begin{cases} kx(1-x); & 0 \le x \le 1 \\ 0; & \text{otherwise} \end{cases}$$

a) Find the value of k. (7 Marks)

b) Find the expected value $E(X)$. (9 Marks)

c) Find the variance $V(X)$. (9 Marks)

ii) The diameters of a batch of machine-made ball bearings are normally distributed with a mean of 12 mm and a standard deviation of 0.4 mm.

a) What is the probability that a randomly selected ball bearing has a diameter greater than 12.5 mm? (7 Marks)

b) What is the probability that a ball bearing has a diameter between 11.2 mm and 12.3 mm? (10 Marks)

c) If the probability that the diameter of a ball bearing exceeds d is 0.0918, find the value of d. (8 Marks)

iii) A technician is testing the lifespan (in hours) of a sample of 8 LED light bulbs. The measured lifespans are:

$$102, 98, 100, 101, 99, 97, 103, 100$$

If the measurement for bulb i is y_i, it is given that $\sum_{i=1}^{8} {y_i}^2 = 80202$.

Construct a 95% confidence interval for the population variance. (25 Marks)

iv) An engineer is comparing the breaking strength of two types of steel rods used in construction. Two independent random samples are taken from the two manufacturing processes:

- **Process A**:
  $n_1 = 10$, mean breaking strength = 540 MPa,
  standard deviation =12 MPa
- **Process B**:
  $n_2 = 12$, mean breaking strength = 530 MPa,
  standard deviation =15 MPa

Assume the breaking strength of rods from each process is normally distributed, and the population variances are unknown but equal.

At the 5% significance level, test whether the rods from Process A have a significantly higher mean breaking strength than those from Process B. (25 Marks)

Additional Information

Partial Derivatives

$$D = f_{xx}f_{yy} - (f_{xy})^2$$

Vector Calculus

The gradient of the scalar field $\phi = f(x,y,z)$ is $\quad \text{grad}\ \phi = \underline{\nabla}\phi = \frac{\partial \phi}{\partial x}\underline{i} + \frac{\partial \phi}{\partial y}\underline{j} + \frac{\partial \phi}{\partial z}\underline{k}$

Consider the vector field $\underline{F} = F_1\underline{i} + F_2\underline{j} + F_3\underline{k}$. $\quad \text{div}\ \underline{F} = \frac{\partial F_1}{\partial x} + \frac{\partial F_2}{\partial y} + \frac{\partial F_3}{\partial z}$.

The curl of the vector field given by $\underline{F} = F_1\underline{i} + F_2\underline{j} + F_3\underline{k}$ is defined as the vector field

$$\text{curl}\ \underline{F} = \underline{\nabla} \times \underline{F} = \begin{vmatrix} \underline{i} & \underline{j} & \underline{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ F_1 & F_2 & F_3 \end{vmatrix}$$

Fourier Series

$$a_n = \frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} f(t)\cos\left(\frac{2n\pi t}{T}\right)dt \qquad n = 0, 1, 2\ldots$$

$$b_n = \frac{2}{T}\int_{-\frac{T}{2}}^{\frac{T}{2}} f(t)\sin\left(\frac{2n\pi t}{T}\right)dt \qquad n = 1, 2\ldots$$

These integrals give the Fourier coefficients for a function of period T whose Fourier series is

$$f(t) = \frac{a_0}{2} + \sum_{n=1}^{\infty}\left\{a_n\cos\left(\frac{2n\pi t}{T}\right) + b_n\sin\left(\frac{2n\pi t}{T}\right)\right\}$$

Continuous Random Variable

Let X be a continuous random variable with associated pdf $f(x)$. Then its expectation and variance denoted by $\mathsf{E}(X)$ (or μ) and $\mathsf{V}(X)$ (or σ^2) respectively are given by:

$$\mu = \mathsf{E}(X) = \int_{-\infty}^{\infty} x\ f(x)dx$$

and

$$\sigma^2 = \mathsf{V}(X) = \int_{-\infty}^{\infty}(x-\mu)^2 f(x)dx = \int_{-\infty}^{\infty} x^2 f(x)dx - \mu^2$$

Point Estimation

We estimate μ using the sample mean: $\bar{y} = \frac{\sum y_i}{n}$

We estimate σ^2 using the sample variance:

$$s^2 = \frac{1}{n-1}\sum(y_i - \bar{y})^2 = \frac{1}{n-1}\left\{\sum y_i^2 - \frac{1}{n}\left[\sum y_i\right]^2\right\}$$

Interval Estimation

It follows that if we do not know the population variance, we must use the estimate $\hat{\sigma}$ in place of σ. Our 95% and 99% confidence intervals (for large samples) become

$$\bar{x} - 1.96\frac{\hat{\sigma}}{\sqrt{n}} \leq \mu \leq \bar{x} + 1.96\frac{\hat{\sigma}}{\sqrt{n}} \quad \text{and} \quad \bar{x} - 2.58\frac{\hat{\sigma}}{\sqrt{n}} \leq \mu \leq \bar{x} + 2.58\frac{\hat{\sigma}}{\sqrt{n}}$$

where

$$\hat{\sigma}^2 = \frac{\sum(x - \bar{x})^2}{n-1}$$

If $x_1, x_2, x_3, \cdots, x_n$ is a random sample with variance S^2 taken from a normal population with variance σ^2 then a $100(1-\alpha)\%$ confidence interval for σ^2 is

$$\frac{(n-1)S^2}{\chi^2_{\alpha/2,n-1}} \leq \sigma^2 \leq \frac{(n-1)S^2}{\chi^2_{1-\alpha/2,n-1}}$$

where $\chi^2_{\alpha/2,n-1}$ and $\chi^2_{1-\alpha/2,n-1}$ are the appropriate right-hand and left-hand values respectively of a chi-squared distribution with $n-1$ degrees of freedom.

Test Concerning Two Samples (Unknown But Equal Variances)

$$T = \frac{(\bar{X}_1 - \bar{X}_2) - (\mu_1 - \mu_2)}{S_c\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

will follow Student's t-distribution with $n_1 + n_2 - 2$ degrees of freedom.

$$S_c^2 = \frac{(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2}{n_1 + n_2 - 2}$$

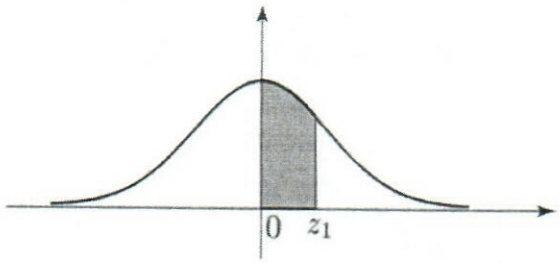
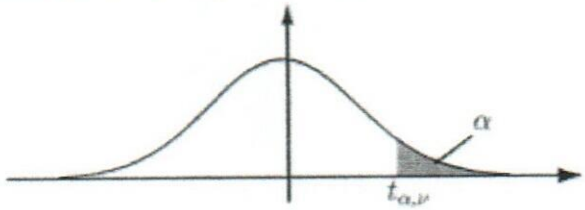


Figure 3

Table 1: The Standard Normal Probability Integral

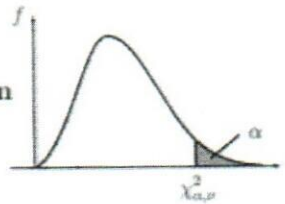
$Z=\frac{x-\mu}{\sigma}$	0	1	2	3	4	5	6	7	8	9
0	0000	0040	0080	0120	0160	0199	0239	0279	0319	0359
.1	0398	0438	0478	0517	0577	0596	0636	0675	0714	0753
.2	0793	0832	0871	0909	0948	0987	1026	1064	1103	1141
.3	1179	1217	1255	1293	1331	1368	1406	1443	1480	1517
.4	1555	1591	1628	1664	1700	1736	1772	1808	1844	1879
.5	1915	1950	1985	2019	2054	2088	2123	2157	2190	2224
.6	2257	2291	2324	2357	2389	2422	2454	2486	2517	2549
.7	2580	2611	2642	2673	2703	2734	2764	2794	2822	2852
.8	2881	2910	2939	2967	2995	3023	3051	3078	3106	3133
.9	3159	3186	3212	3238	3264	3289	3315	3340	3365	3389
1.0	3413	3438	3461	3485	3508	3531	3554	3577	3599	3621
1.1	3643	3665	3686	3708	3729	3749	3770	3790	3810	3830
1.2	3849	3869	3888	3907	3925	3944	3962	3980	3997	4015
1.3	4032	4049	4066	4082	4099	4115	4131	4147	4162	4177
1.4	4192	4207	4222	4236	4251	4265	4279	4292	4306	4319
1.5	4332	4345	4357	4370	4382	4394	4406	4418	4429	4441
1.6	4452	4463	4474	4484	4495	4505	4515	4525	4535	4545
1.7	4554	4564	4573	4582	4591	4599	4608	4616	4625	4633
1.8	4641	4649	4656	4664	4671	4678	4686	4693	4699	4706
1.9	4713	4719	4726	4732	4738	4744	4750	4756	4761	4767
2.0	4772	4778	4783	4788	4793	4798	4803	4808	4812	4817
2.1	4821	4826	4830	4834	4838	4842	4846	4850	4854	4857
2.2	4861	4865	4868	4871	4875	4878	4881	4884	4887	4890
2.3	4893	4896	4898	4901	4904	4906	4909	4911	4913	4916
2.4	4918	4920	4922	4925	4927	4929	4931	4932	4934	4936
2.5	4938	4940	4941	4943	4946	4947	4948	4949	4951	4952
2.6	4953	4955	4956	4957	4959	4960	4961	4962	4963	4964
2.7	4965	4966	4967	4968	4969	4970	4971	4972	4973	4974
2.8	4974	4975	4976	4977	4977	4978	4979	4979	4980	4981
2.9	4981	4982	4982	4983	4984	4984	4985	4985	4986	4986
	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9
	4987	4990	4993	4995	4997	4998	4998	4999	4999	4999

Table 2: Percentage Points of the Students t-distribution



α	.40	.25	.10	.05	.025	.01	.005	.0025	.001	.0005
ν										
1	.325	1.000	3.078	6.314	12.706	31.825	63.657	127.32	318.31	636.62
2	.289	.816	1.886	2.902	4.303	6.965	9.925	14.089	23.326	31.598
3	.277	.765	1.638	2.353	3.182	4.514	5.841	7.453	10.213	12.924
4	.271	.741	1.533	2.132	2.776	3.747	4.604	5.598	7.173	8.610
5	.267	.727	1.476	2.015	2.571	3.365	4.032	4.773	5.893	6.869
6	.265	.718	1.440	1.943	2.447	3.143	3.707	4.317	5.208	5.959
7	.263	.711	1.415	1.895	2.365	2.998	3.499	4.029	4.785	5.408
8	.262	.706	1.397	1.860	2.306	2.896	3.355	3.833	4.501	5.041
9	.261	.703	1.383	1.833	2.262	2.821	3.250	3.690	4.297	4.781
10	.260	.700	1.372	1.812	2.228	2.764	3.169	3.581	4.144	4.487
11	.260	.697	1.363	1.796	2.201	2.718	3.106	3.497	4.025	4.437
12	.259	.695	1.356	1.782	2.179	2.681	3.055	3.428	3.930	4.318
13	.259	.694	1.350	1.771	2.160	2.650	3.012	3.372	3.852	4.221
14	.258	.692	1.345	1.761	2.145	2.624	2.977	3.326	3.787	4.140
15	.258	.691	1.341	1.753	2.131	2.602	2.947	3.286	3.733	4.073
16	.258	.690	1.337	1.746	2.120	2.583	2.921	3.252	3.686	4.015
17	.257	.689	1.333	1.740	2.110	2.567	2.898	3.222	3.646	3.965
18	.257	.688	1.330	1.734	2.101	2.552	2.878	3.197	3.610	3.922
19	.257	.688	1.328	1.729	2.093	2.539	2.861	3.174	3.579	3.883
20	.257	.687	1.325	1.725	2.086	2.528	2.845	3.153	3.552	3.850
21	.257	.686	1.323	1.721	2.080	2.518	2.831	3.135	3.527	3.819
22	.256	.686	1.321	1.717	2.074	2.508	2.819	3.119	3.505	3.792
23	.256	.685	1.319	1.714	2.069	2.500	2.807	3.104	3.485	3.767
24	.256	.685	1.318	1.711	2.064	2.492	2.797	3.091	3.467	3.745
25	.256	.684	1.316	1.708	2.060	2.485	2.787	3.078	3.450	3.725
26	.256	.684	1.315	1.706	2.056	2.479	2.779	3.067	3.435	3.707
27	.256	.684	1.314	1.703	2.052	2.473	2.771	3.057	3.421	3.690
28	.256	.683	1.313	1.701	2.048	2.467	2.763	3.047	3.408	3.674
29	.256	.683	1.311	1.699	2.045	2.462	2.756	3.038	3.396	3.659
30	.256	.683	1.310	1.697	2.042	2.457	2.750	3.030	3.385	3.646
40	.255	.681	1.303	1.684	2.021	2.423	2.704	2.971	3.307	3.551
60	.254	.679	1.296	1.671	2.000	2.390	2.660	2.915	3.232	3.460
120	.254	.677	1.289	1.658	1.980	2.358	2.617	2.860	3.160	3.373
∞	.253	.674	1.282	1.645	1.960	2.326	2.576	2.807	3.090	3.291

Table 3 : Percentage Points $\chi^2_{\alpha,\nu}$ of the χ^2 distribution



α	0.995	0.990	0.975	0.950	0.900	0.500	0.100	0.050	0.025	0.010	0.005
υ											
1	0.00	0.00	0.00	0.00	0.02	0.45	2.71	3.84	5.02	6.63	7.88
2	0.01	0.02	0.05	0.01	0.21	1.39	4.61	5.99	7.38	9.21	10.60
3	0.07	0.11	0.22	0.35	0.58	2.37	6.25	7.81	9.35	11.34	12.28
4	0.21	0.30	0.48	0.71	1.06	3.36	7.78	9.49	11.14	13.28	14.86
5	0.41	0.55	0.83	1.15	1.61	4.35	9.24	11.07	12.83	15.09	16.75
6	0.68	0.87	1.24	1.64	2.20	5.35	10.65	12.59	14.45	16.81	18.55
7	0.99	1.24	1.69	2.17	2.83	6.35	12.02	14.07	16.01	18.48	20.28
8	1.34	1.65	2.18	2.73	3.49	7.34	13.36	15.51	17.53	20.09	21.96
9	1.73	2.09	2.70	3.33	4.17	8.34	14.68	16.92	19.02	21.67	23.59
10	2.16	2.56	3.25	3.94	4.87	9.34	15.99	18.31	20.48	23.21	25.19
11	2.60	3.05	3.82	4.57	5.58	10.34	17.28	19.68	21.92	24.72	26.76
12	3.07	3.57	4.40	5.23	6.30	11.34	18.55	21.03	23.34	26.22	28.30
13	3.57	4.11	5.01	5.89	7.04	12.34	19.81	22.36	24.74	27.69	29.82
14	4.07	4.66	5.63	6.57	7.79	13.34	21.06	23.68	26.12	29.14	31.32
15	4.60	5.23	6.27	7.26	8.55	14.34	22.31	25.00	27.49	30.58	32.80
16	5.14	5.81	6.91	7.96	9.31	15.34	23.54	26.30	28.85	31.00	34.27
17	5.70	6.41	7.56	8.67	10.09	16.34	24.77	27.59	30.19	33.41	35.72
18	6.26	7.01	8.23	9.39	10.87	17.34	25.99	28.87	31.53	34.81	37.16
19	6.84	7.63	8.91	10.12	11.65	18.34	27.20	30.14	32.85	36.19	38.58
20	7.43	8.26	9.59	10.85	12.44	19.34	28.41	31.41	34.17	37.57	40.00
21	8.03	8.90	10.28	11.59	13.24	20.34	29.62	32.67	35.48	38.93	41.40
22	8.64	9.54	10.98	12.34	14.04	21.34	30.81	33.92	36.78	40.29	42.80
23	9.26	10.20	11.69	13.09	14.85	22.34	32.01	35.17	38.08	41.64	44.18
24	9.89	10.86	12.40	13.85	15.66	23.34	33.20	36.42	39.36	42.98	45.56
25	10.52	11.52	13.12	14.61	16.47	24.34	34.28	37.65	40.65	44.31	46.93
26	11.16	12.20	13.84	15.38	17.29	25.34	35.56	38.89	41.92	45.64	48.29
27	11.81	12.88	14.57	16.15	18.11	26.34	36.74	40.11	43.19	46.96	49.65
28	12.46	13.57	15.31	16.93	18.94	27.34	37.92	41.34	44.46	48.28	50.99
29	13.12	14.26	16.05	17.71	19.77	28.34	39.09	42.56	45.72	49.59	52.34
30	13.79	14.95	16.79	18.49	20.60	29.34	40.26	43.77	46.98	50.89	53.67
40	20.71	22.16	24.43	26.51	29.05	39.34	51.81	55.76	59.34	63.69	66.77
50	27.99	29.71	32.36	34.76	37.69	49.33	63.17	67.50	71.42	76.15	79.49
60	35.53	37.48	40.48	43.19	46.46	59.33	74.40	79.08	83.30	88.38	91.95
70	43.28	45.44	48.76	51.74	55.33	69.33	85.53	90.53	95.02	100.42	104.22
80	51.17	53.54	57.15	60.39	64.28	79.33	96.58	101.88	106.63	112.33	116.32
90	59.20	61.75	65.65	69.13	73.29	89.33	107.57	113.14	118.14	124.12	128.30
100	67.33	70.06	74.22	77.93	82.36	99.33	118.50	124.34	129.56	135.81	140.17

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