TECHNICAL UNIVERSITY OF MOMBASA

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

UNIVERSITY EXAMINATIONS FOR:

THE DEGREE OF BACHELOR OF SCIENCE/TECHNOLOGY IN CIVIL ENGINEERING

(ECV3S1/Y2S1)

ECV 4315/TCV 4212: SOIL MECHANICS I

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: JULY 2025

TIME: 2 HOURS

INSTRUCTIONS TO THE CANDIDATE:

1. You should have the following for this examination:
    - **Answer booklet.**
    - **Mathematical Table/Pocket Calculator.**
2. This paper consists of **FOUR** questions.
3. Answer question **ONE (Compulsory)** and any other **TWO** questions.
4. This paper consists of **FIVE** printed pages.
5. **Do not write on the question paper.**

Question ONE (compulsory): Soil properties

(a)*Bulk unit weight for a partially saturated soil,*

$$\gamma_b = \left\{\frac{G_s + eS_r}{1+e}\right\}\gamma_w \qquad equation\ 1.1$$

Derive equation 1.1 from basic principles.

(10 marks)

(b)A soil sample in its natural state has a mass of 1.762 kg and a volume of 1.0 x10^{-3} m^3. In an oven dried state, the dry mass of the sample is 1.368 kg and the specific gravity G_s of the solids is 2.69.

Determine:

(i) The bulk density,
(ii) The bulk unit weight,
(iii) Water content,
(iv) The dry unit weight,
(v) Void ratio,
(vi) Saturated unit weight,
(vii) Sub-merged unit weight,
(viii) Porosity,
(ix) Degree of saturation,
(x) Air voids ratio.

(20 marks)

Question TWO: Soil classification

The results of a sieve analysis, on a soil sample are presented in Table 2.1.

For the soil tested, plot the standard grading curve and hence determine:

(i) The sizes: D_{10}(effective size), D_{30} and D_{60},
(ii) Uniformity coefficient,
(iii) Coefficient of curvature.

Table 2.1: Sieve analysis results

Sieve size (mm)	Mass retained (g)
5.00	0.0
2.00	8.0
1.18	7.0
0.600	11.0
0.300	21.0
0.212	63.0
0.150	48.0
0.063	14.0
Mass passing 0.063	3.0

(20 marks)

Question THREE: Soil Compaction

The results of a compaction test are set in table 3.1.

Table 3.1

Moisture content (%)	6.8	8.5	9.4	10.2	11.3	12.5	13.6
Bulk density (kg/m^3)	2070	2140	2180	2210	2230	2210	2190

Specific gravity of solids $G_s = 2.7$

(i) Plot the curve of dry density against moisture content and determine the values of maximum dry density and optimum moisture content,

(ii)On the same axes, plot the 0.0% and 5% air voids lines,

(iii)Calculate the water content required for full saturation at maximum dry density.

Hint:

Moisture content		%	6.8	8.5	9.4	10.2	11.3	12.5	13.6
		Decimal (w)							
Bulk density $\rho_b = \frac{mass\ of\ soil}{vol.\ of\ mould}$ (kg/m^3)			2070	2140	2180	2210	2230	2210	2190
Dry density (kg/m^3)	$\rho_d = \frac{\rho_b}{1+w}$								
	$\rho_d = \frac{G_s(1-A_r)}{1+wG_s}\rho_w$	For saturation line, $A_r = 0$							
		For 5% air voids, $A_r = 0.05$							

(20 marks)

Question FOUR: Soil stress analysis

A 5 m square foundation exerts a uniform pressure of 300 kN/m^2 on a soil.

Determine:

(i) The vertical stress increment due to the foundation at a depth of 10.0 m below its centre,

(ii) The vertical stress increment at a point 5.0 m below the foundation and 5.0 m from its centre along one of the axes of symmetry.

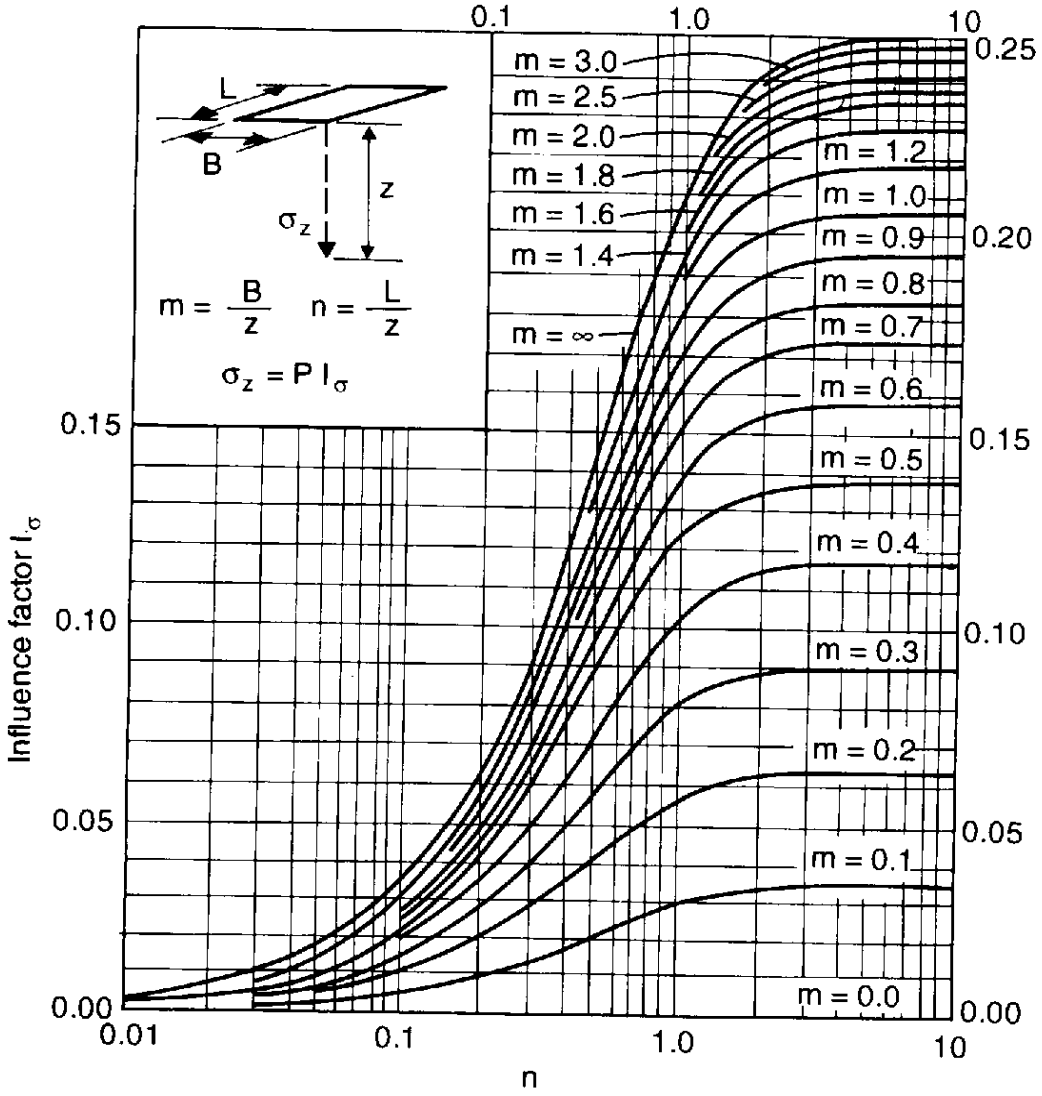

Fig.4: Influence factors for the vertical stress beneath the corner of a rectangular foundation (Fadum, 1941)

(20 marks)