National Exams May 2011

04-Env-A3, Geotechnical and Hydrogeological Engineering

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM.
   Any non-communicating calculator is permitted.

3. Five (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

4. Each question is of equal value.

5. Some questions require an answer in written format. Clarity and organization of the answer are important.

1. (20 Marks) Define (briefly) the following terms:
    a. Saturated Hydraulic Conductivity
    b. Effective stress
    c. Undrained triaxial shear stress
    d. Pump Test
    e. Quick condition
    f. Shrinkage limit
    g. Normally consolidated
    h. Angle of friction
    i. Bearing capacity
    j. Plastic limit

2. (20 Marks) A 4.0 m thick layer of clay lies between two layers of sand each 5.0 m thick, the top layer of sand is at the ground level. The water table is 4.0 m below the ground level in the sand layer and the lower layer of sand is under artesian pressure, the piezometric surface for the lower layer being 1.0 m below the ground surface. Saturated unit weights of the clay and sand are 20 and 19 kN/m^3, respectively, and the unit weight of the sand above the water table is 16.5 kN/m^3. Determine the total, pore and effective stresses at the top and bottom of the clay layer.

3. (20 Marks) A tube sampler is used to extract a soil sample for analysis in a soils investigation. The following information is obtained:

   Container and soil sample: 3540 g
   Length and diameter of soil sampler: 20.1 and 8.5 cm, respectively
   Mass of soil after drying: 2035 g
   Specific gravity of soil particles: 2.68

   Determine:

   a. Sample bulk density
   b. Unit weight of soil
   c. Water content
   d. Void Ratio
   e. Porosity
   f. Degree of saturation

4. (20 Marks) The table below gives the results from a standard compaction test on a soil using a mold with a 1000 cm^3 volume. Using a value of the soil grain specific gravity of 2.67:

   a. Plot the dry density-water content curve (a chart is provided at the end of the test for this),
   b. Determine the optimum water content,
   c. Determine the maximum dry density
   d. Value of the air content at the maximum dry density.

Mass (g)	2010	2092	2114	2100	2055
water content (%)	12.8	14.5	15.6	16.8	19.2

5. (20 Marks) A field constructed falling head permeameter is used to estimate the in situ permeability of soils. In this device a 15 cm inside diameter, 150 cm long pipe is pushed into the soil a distance of 100 cm and withdrawn with the 100 cm length of soil intact. A cap is placed over the bottom and a tube run from the bottom up to the level of the soil in the pipe but outside the pipe. The pipe is then filled with water until the soil is fully saturated and the water level I is at the top of the pipe with 50 cm of water on top of the soil. The distance below the top of the pipe to the water level and the time are recorded as the water passes through the soil and out through the tube.
   a. What is the saturated hydraulic conductivity of the soil?
   b. What aspects of this procedure could you suggest for improvement to determine the saturated hydraulic conductivity?

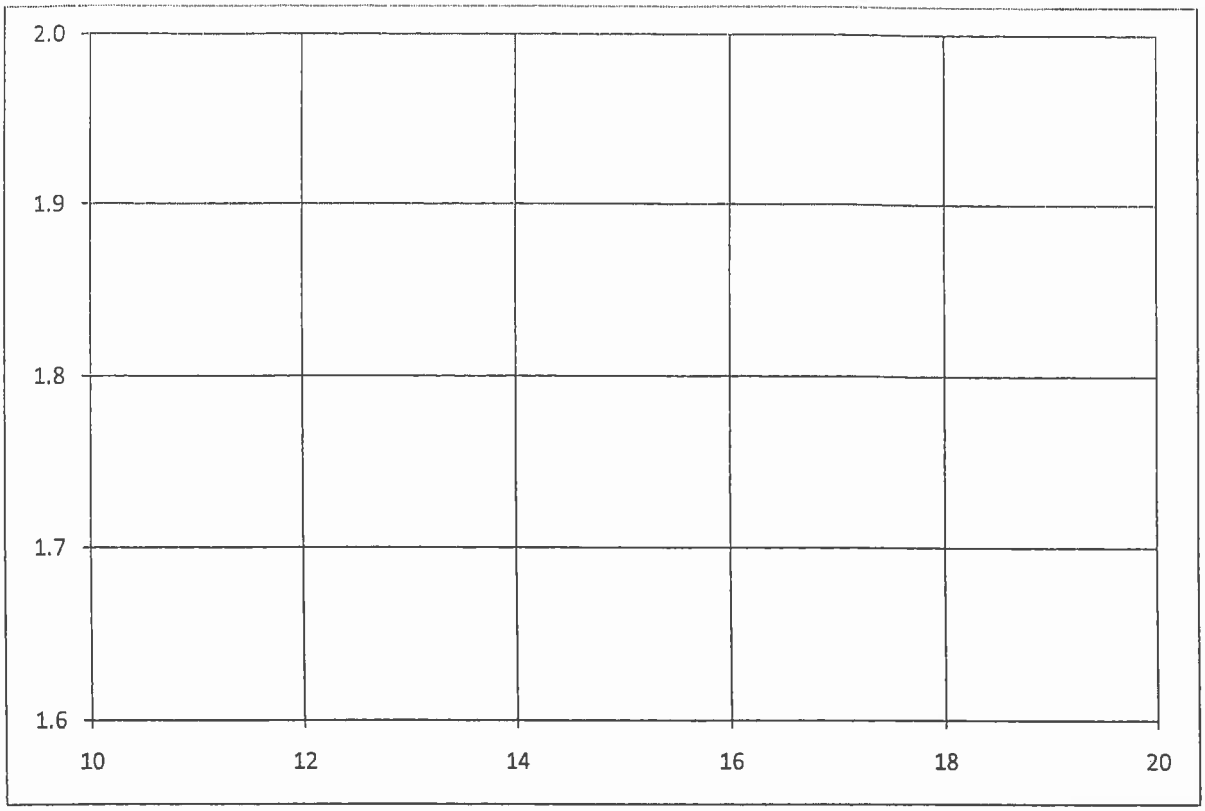
Time (min)	0	30	60	90	120	180
Depth to Water (cm)	0	13	23	30	35	42

6. (20 Marks) A sandy clay soil sample was collected in the field and returned to the lab for a shear box (direct shear) test. The specimen in the box had dimensions of 55x55 mm and the results of the test are given in the table below.
   a. Determine the apparent cohesion and angle of friction of the soil (a sheet of graph paper is supplied with this question that may be of use – submit this with your answer booklet if you use it.)
   b. Discuss the accuracy of the results
   c. What other options are there for determining the shear strength parameters for soils and when might they be more appropriate than the approach used here?

Shear Box Test Results

Normal Load (N)	Shear Load at Failure (N)			
108	172			
202	227			
295	266			
390	323			
484	374			
576	425			

Chart for Question 4 – include this with your answer book.



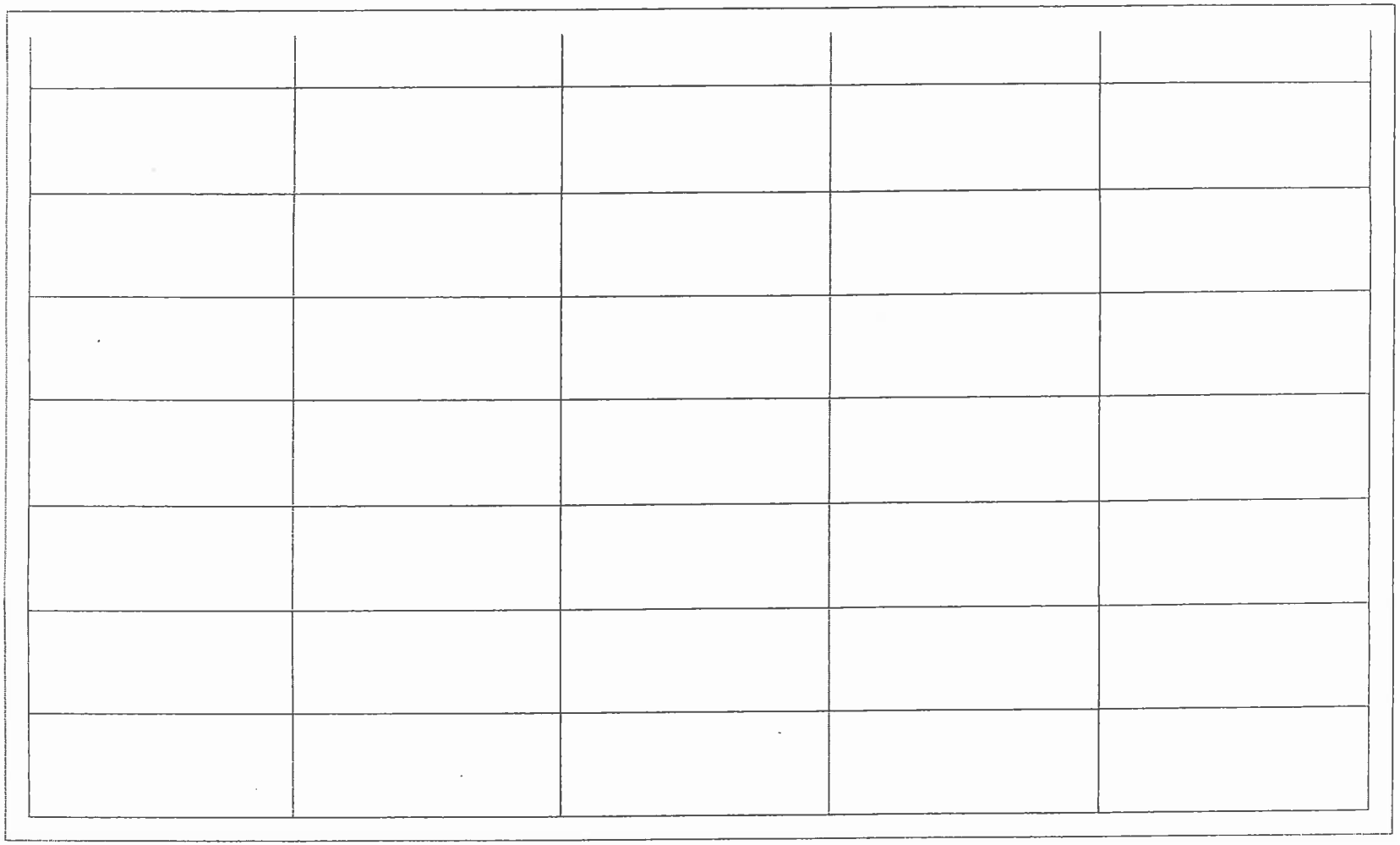


Figure for use with Queston 6