THE OPEN UNIVERSITY OF SRI LANKA

00101

Bachelor of Technology (Civil) - Level 5

CEX5232 – Engineering Geology

Final Examination -2012

Date: 21-02-2012 (Tuesday) Time Allowed: Three (03) hours

Answer Five (05) questions out of Eight (08) questions.
Answers should be illustrated with sketches and diagrams with assumptions stated, clearly and neatly

(Q1) A new subway is to be constructed in the Jaffna peninsula to improve the traffic conditions of the area. Suppose you have been selected as the professional geotechnical engineer to assess the geotechnical feasibility of the project.

(i) **Describe briefly** the possible geology of underlying bedrocks that can be expected in this area. *(06 marks)*

(ii) Considering the answer to the ***Question (Q1) (i)***, **briefly discuss** about the engineering geological considerations of underlying bedrocks that may need to address in construction of above mentioned subway. *(08 marks)*

(iii) **Propose** a geotechnical investigation programme for this project, which will enable to acquire necessary information in addressing the above mentioned engineering geological considerations in ***Question (Q1) (ii)***. *(06 marks)*

(Q2) Carrying out construction work in earthquake prone areas need extreme attention, especially with respect to engineering geological considerations.

(i) **State Four (04)** types of earth zones where there is a high possibility of strong earth tremors or seismic activities can be occurred. *(06 marks)*

(ii) **State and briefly explain** about **Three (03)** engineering geological conditions that will favor the construction (structures in these areas will have minimum impact from seismic activities) in earthquake prone areas. *(08 marks)*

(iii) **Briefly describe** the protection measures adopted in construction of roads in hilly areas, where seismic action is active. *(06 marks)*

(Q3) ***"Assessment of rock mass characteristics is very essential in carrying out any construction work both inside and above rock structure".***

(i) **Briefly describe** the statement with the use of your knowledge in rock mass classification systems. *(06 marks)*

(ii) **Briefly describe** about the forms of rock discontinuities with the use of examples. *(07 marks)*

(iii) **Compare** the **two** rock mass classification systems, 'RMR' (Rock Mass Rating) and 'Q' systems considering their applications and relative merits and demerits. *(07 marks)*

(Q4) (i) **Evaluate** the groundwater potential of following geological formations.

(a) Alluvial Deposit consists of clay layer of 3.00 m followed by coarse sand 4.60 m followed by bedrock adjacent to an influent stream. *(04 marks)*

(b) Granitic Gneiss formation adjacent to a reservoir. *(04 marks)*

(c) Sandstone formation connected to a river bed. *(04 marks)*

(d) Fractured Quartzite formation connected to an irrigation tank *(04 marks)*

(ii) Using the evaluation done in above ***Question Q4(i)***, **arrange** the above mentioned 04 geological formations **in ascending order** of using them as potential aquifers. *(04 marks)*

(Q5) A new irrigation tank is to be constructed in Matale area to supply water for paddy cultivation. For this purpose, Two boreholes (Table Q5.1 and Table Q5.2) were done in order to find the best location for the Irrigation Tank

Borehole -01 Details

Table Q5.1

Layer Number from top	Layer thickness (m)	Layer Description
01	0.70	Loose-Black silty sandy clay
02	2.46	Medium dense-Brown silty medium to coarse sand
03	1.90	Medium dense to dense-Yellowish Brown silty medium to coarse sand with mica and quartzite(residual soil)
04	1.85	Feldspar Band
05	1.15	Moderately weathered rock
06	Below 8.06 m depth	Fresh rock of Quartzo Feldspathic Gneiss (Foliation planes are almost horizontal)

Borehole -02 Details

Table Q5.2

Layer Number from top	Layer thickness (m)	Layer Description
01	0.25	Brown silty sand with organic matter
02	3.15	Medium dense-Reddish brown silty medium to coarse sand with quartzite
03	1.30	Dense- Quartzite boulders
04	2.62	Marble band
05	2.38	Moderately to slightly weathered rock
06	Below 9.70 m depth	Fresh rock of Biotite Gneiss banded with heavily concentrated mica intrusions dipping 30^0-40^0 away from the area.

Suppose you have been appointed as the professional engineering geologist to evaluate in choosing the most suitable location for construction of above irrigation tank.

(i) **Evaluate** the Engineering Geological conditions at Borehole -01 location using your basic knowledge in properties minerals and rocks and data given in Table Q5.1. *(08 marks)*

(ii) **Evaluate** the Engineering Geological conditions at Borehole -02 location using your basic knowledge in properties minerals and rocks and data given in Table Q5.2. *(08 marks)*

(iii) **Propose** the most suitable location for construction of particular tank comparing the engineering geological conditions evaluated in above ***Question Q5 (i)*** and ***Q5 (ii)***. *(04 marks)*

(Q6) A Petroleum storage tanking facility is proposed to be constructed in Muthurajawela swamp. This is after filling the the particular area to height of about 3.00 m. The average load imposed by the foundations and fill is 175 k Pa. A ground improvement process is proposed in this context to improve the underlying soils.

(i) **Identify** the most critical type of soil that can be encountered in this area and **briefly explain** the possible engineering properties of identified soil. *(04 marks)*

(ii) **Identify** the most essential soil parameters that should be determined in designing of above foundations as well as ground improvement process and **identify** the most essential laboratory tests that should be performed in obtain these soil parameters. *(06 marks)*

(iii) **Develop** a subsurface exploratory drilling program that should be performed in this area in order to obtain the necessary soil parameters and to perform laboratory tests identified in ***Question Q6 (ii)***. In your answer following aspects should be clearly mentioned.
(i) Drilling methodology, (ii) In-situ tests that will need to be performed (with reasons for performing the test), (iii) Depth of exploration, (iv) Methods of sampling. *(10 marks)*

(Q7) Geotechnical investigation details are given below in Table Q7.1 for construction of a new Hotel Complex 00101 in hilly area of Kandy District, in a slope ground terrain area having an average slope of 45^0 to 50^0.

Table Q7.1

Depth (m)	Geological Profile	Remarks
Surface level to 0.35	Silty clayey medium sand with some clay and organic matter	Organic matter can be observed
0.35-1.24	Silty clayey medium to coarse sand (Residual soil)	Medium dense to dense in relative density
1.24-2.82	Highly decomposed rock disintegrating to coarse sand with gravel, traces of clay, mica and rock boulders	Dense to very dense in relative density
2.82-4.92	Partially weathered Feldspar band	The top and bottom parts of the layer is highly weathered
4.92-6.84	Fracture zone saturated with water	Considerable amount of Groundwater flow can be observed
6.84-8.06	Bedrock of Quartzo Feldspathic Gneiss	Moderately weathered and highly fractured
>8.06	Bedrock of Quartzo Feldspathic Gneiss	Foliation planes are striking parallel to slope direction, dipping 36^0 parallel to the slope. Two major joint sets striking parallel to foliation planes and dipping in the same direction having dip angles of 27^0 and 51^0. Joint spacing is 5.00 m

(i) It is clear that underlying bedrock is weathered to certain extent that can be observed as thick soil profile. **Briefly discuss** the possible effects of weathering on both the **physical properties** and **engineering properties** of a fresh bed rock. *(05 marks)*

(ii) **Evaluate** the feasibility in constriction of above mentioned hotel complex in this terrain with respect to engineering geological considerations. *(08 marks)*

(iii) **Evaluate** the potential for constructing a tube well in this area for supply of water for the proposed hotel complex. *(07marks)*

(Q8) The below given Figure Q8.1 is an area topographic map which shows 04 borehole locations (**A, B, C** and **D**) done to investigate the area geology for the construction of a new tunnel. The proposed tunnel axis is shown as **X-X**.

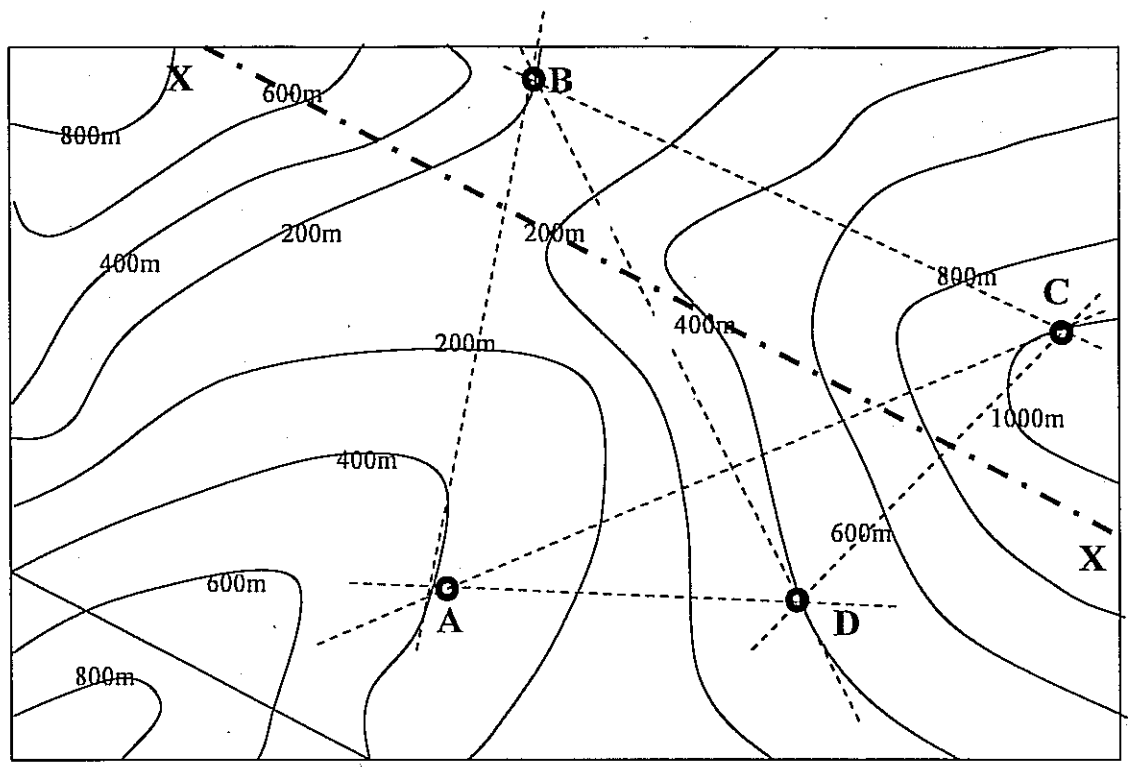

Figure Q8.1

Not to Scale

Since map shown in above Figure Q8.1 is not drawn to a scale, following Table Q8.1 provides the map details.

Table Q8.1

Borehole Point	Line Reference Name	Perpendicular Distance from the line (m)
A	BD	378
	BC	900
	DC	350
B	AC	800
	AD	950
	DC	935
C	AB	860
	BD	650
	DA	380
D	AB	300
	BC	450
	AC	200

An engineering geologically unfavorable marble (crystalline limestone) layer encountered in boreholes A, B, and C at 150 m, 140 m and 750 m depths respectively.

(i) **Determine** the **Strike** direction and the **Dip** angle of the marble layer. *(08 marks)*

(ii) At what depth this marble layer is encountered in borehole D location? *(04 marks)*

(iii) Suppose the proposed tunnel axis is cutting AB, BD, AC and DC lines at angles of 80^0, 30^0, 60^0 and 85^0 respectively. Suppose you are the apponited tunneling engineer in excavating this tunnel. **Determine** the Apparent Dip angle of this marble layer that you will experience during the process of tunnel excavation. *(08 marks)*