UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2011/2012

COURSE NAME	:	GEO-ENVIRONMENT
COURSE CODE	:	BFG 40303/BFG 4033
PROGRAMME	:	4 BFF
EXAMINATION DATE	:	JUNE 2012
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **EIGHT(8)** PAGES

Q1 (a) Define and provide an example of the following mechanisms:

(i) macroencapsulation,
(ii) microencapsulation,
(iii) adsorption, and
(iv) leachability index.

(4 marks)

(b) Explain the differences in stabilization processes with the use of portland cement versus lime as the stabilizing agent for a contaminated soil.

(3 marks)

(c) Describe in detail and with the aid of a diagram the procedures of a semi-dynamic leaching test (e.g. ANS 16.1 (ANS, 1986)).

(6 marks)

(d) Sampels were prepared by mixing cement with soil contaminated with lead. The size of each cylindrical sampel is 5 cm (height) and 1 cm (diameter). The initial amount of lead in the sampel was 44.4 mg. Leaching procedures, as described by ANS 16.1 were performed and the test results are shown in **Table 1.**

Calculate:

(i) the effective diffusion coefficient and
(ii) the leachability index. Comment on the result of the index.

Table 1: Results of ANS 16.1 leaching test

Sampling time, t (h)	Leachate concentration, c_i (mg/l)	Cumulative pollutant loss, (Σc_i (mg))	$\Sigma c_i/c_o$ (%)
2	1.150	1.725	3.88
7	0.745	2.842	6.40
24	1.303	4.796	10.80
48	0.779	5.964	13.43
72	0.596	6.858	15.44
96	0.370	7.413	16.69
120	0.305	7.870	17.72
192	0.694	8.911	20.06
264	0.493	9.650	21.73
336	0.613	10.570	23.81
504	0.655	11.552	26.02
672	0.276	11.966	26.95

(12 marks)

Q2 (a) List **THREE(3)** physical processes which affect the flow of solute (contaminants) in groundwater?

(3 marks)

(b) Define mechanical dispersion.

(3 marks)

(c) **Differentiate between molecular diffusion, advective diffusion and turbulent diffusion.**

(7 marks)

(d) For a contaminant flow in soils/aquifers, use the Ogata & Banks solution, shown below, to determine the breakthrough curves if the dispersion is $4cm^2/h$, x = 20 cm and the mean velocity is 4 cm/h. Determine the curve for a time of 2hr. Use the **Table 2** for the complementary error function values. Comment briefly on your solution.

$$\frac{c(x,t)}{C_o} = \frac{1}{2}\left\{erfc\left(\frac{x - v_s t}{2\sqrt{D_{hd} t}}\right) + \exp\left(\frac{v_s x}{D_{hd}}\right) * erfc\left(\frac{x + v_s t}{2\sqrt{D_{hd} t}}\right)\right\}$$

where $c\ (x,t)$ = the concentration at any distance x > 0
C_o = the initial contaminant concentration, g/m^3
v_s = average velocity, m/s
D_{hd} = dispersion coefficient
erfc = complementary error function
exp = exponent

(12 marks)

Q3 (a) Discuss the advantages and disadvantages of ex-situ and in-situ remediation approaches?

(8 marks)

(b) Draw a flowchart showing in-situ and ex-situ soil remediation technologies. Subdivide these technologies according to physical, chemical, electrical, thermal, or biological methods.

(8 marks)

(c) A soil is contaminated with 300 mg/kg of PCE. Soil washing is proposed with a solids concentration of 0.1 kg/L.
Calculate the soil washing removal efficiency if

(i) water is used as the washing solution (with K_d = 100 L/kg), and

(ii) a solvent is used as the washing solution (with K_d = 10 L/kg).

(9 marks)

Q4 A former industrial site is to be redeveloped to become a private housing with gardens. The site is roughly rectangular in shape with dimensions of 150 m x 300 m (4.5 hectares). A plan of the site is given in **FIGURE Q4**.

An investigation is to be carry out to assess the nature and extent of contamination of the soil and groundwater in sufficient detail to design remediation works to be undertaken as part of the site's redevelopment.

(a) List the investigation strategies/phases that would be practical to implement in order to obtain information on surface and subsurface conditions appropriate for the objective of the investigation.

(8 marks)

(b) Previous geotechnical investigation had revealed the following sequence of strata at the site as in **Table 3** below.

Table 3: Sequence of Strata

Depth (m)	Material
0 – 1.5	Fill , including demolition waste
1.5 – 3..0	Alluvial silty sands with varying propotion of gravel and clay in different areas of the site. Groundwater level at depth of 2 – 2.5 m
3.0 – 6.0	Sedimentary till, generally comprising stiff clay but with occational sandy lenses.
6.0 - > 20	Sandstone

Explain the works that you will carry out in the exploratory or detail phase of the investigation to produce information on the identified hazards so that the actual risk can be assessed and the need for remediation determined.

(12 marks)

(c) List **FIVE (5)** potential sources of site contamination that the risk require assessment.

(5 marks)

Q5 (a) Seldom is a soil exploration done to place a structure over a closed landfill or hazardous waste site , but where exploration is necessary extreme precautions are required.
Explain those extreme precautions.

(10 marks)

(b) A sanitary landfill was constructed for a height of 16 m and the operation was completed after 72 months.

(i) Calculate the length of time (after completion of the land fill) required for the landfill to undergo complete settlement

(ii) Calculate the complete settlement of the landfill if the void ratio(e) of the fill is 0.9 and the coefficient for settlement (α) is for conditions favorable to decomposition which is 0.09e.

(15 marks)

Q6 (a) Contaminants and pollutants contributes towards soil and environmental pollution. Explain the sources of these contributory factors and suggest solutions to reduce the problems.

(8 marks)

(b) Based on your geotechnical and environmental understanding of pollutant-soil interactions, explain briefly the problems that might be caused by this situation when an engineer attempts to construct a structure on contaminated site.

(8 marks)

(c) Explain with example the effects of contaminants on the engineering properties of soils particularly the unconfined compression strength, compressibility and hydraulic conductivity for design and construction purposes?

(9 marks)

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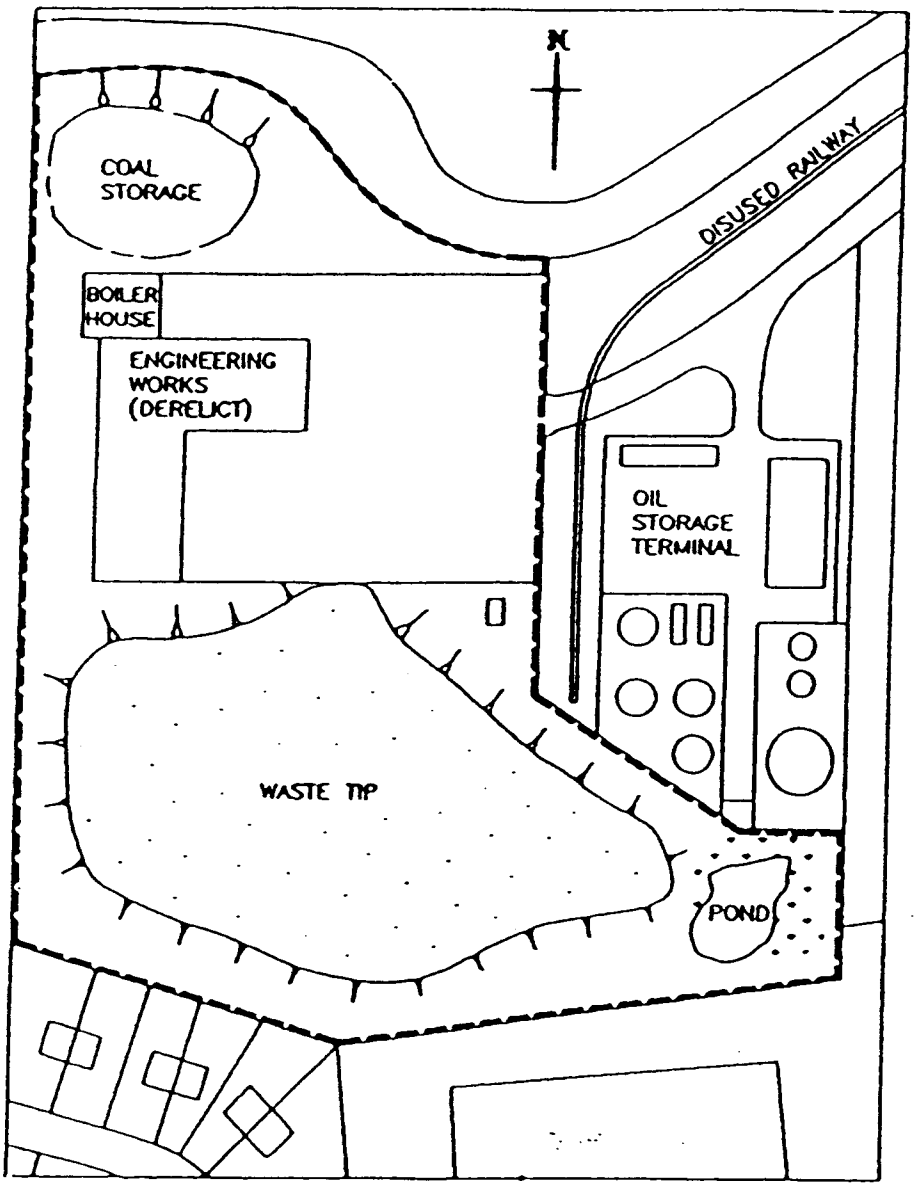

FIGURE Q4

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TABLE 2

Complementary Error Function Table

x	erfc(x)	x	erfc(x)	x	erfc(x)	x	erfc(x)	x	erfc(x)	x	erfc(x)	x	erfc(x)
0	1.000000	0.5	0.479500	1	0.157299	1.5	0.033895	2	0.004678	2.5	0.000407	3	0.00002209
0.01	0.988717	0.51	0.470756	1.01	0.153190	1.51	0.032723	2.01	0.004475	2.51	0.000386	3.01	0.00002074
0.02	0.977435	0.52	0.462101	1.02	0.149152	1.52	0.031587	2.02	0.004281	2.52	0.000365	3.02	0.00001947
0.03	0.966155	0.53	0.453536	1.03	0.145215	1.53	0.030484	2.03	0.004094	2.53	0.000345	3.03	0.00001827
0.04	0.954883	0.54	0.445061	1.04	0.141350	1.54	0.029414	2.04	0.003914	2.54	0.000328	3.04	0.00001714
0.05	0.943628	0.55	0.436677	1.05	0.137564	1.55	0.028377	2.05	0.003742	2.55	0.000311	3.05	0.00001608
0.06	0.932378	0.56	0.428384	1.06	0.133856	1.56	0.027372	2.06	0.003577	2.56	0.000294	3.06	0.00001508
0.07	0.921142	0.57	0.420184	1.07	0.130227	1.57	0.026397	2.07	0.003418	2.57	0.000278	3.07	0.00001414
0.08	0.909922	0.58	0.412077	1.08	0.126674	1.58	0.025453	2.08	0.003266	2.58	0.000264	3.08	0.00001326
0.09	0.898719	0.59	0.404064	1.09	0.123197	1.59	0.024538	2.09	0.003120	2.59	0.000249	3.09	0.00001243
0.1	0.887537	0.6	0.396144	1.1	0.119795	1.6	0.023652	2.1	0.002979	2.6	0.000236	3.1	0.00001165
0.11	0.876377	0.61	0.388319	1.11	0.116467	1.61	0.022793	2.11	0.002845	2.61	0.000223	3.11	0.00001092
0.12	0.865242	0.62	0.380589	1.12	0.113212	1.62	0.021962	2.12	0.002716	2.62	0.000211	3.12	0.00001023
0.13	0.854133	0.63	0.372954	1.13	0.110029	1.63	0.021157	2.13	0.002593	2.63	0.000200	3.13	0.00000958
0.14	0.843053	0.64	0.365414	1.14	0.106918	1.64	0.020378	2.14	0.002475	2.64	0.000189	3.14	0.00000897
0.15	0.832004	0.65	0.357971	1.15	0.103876	1.65	0.019624	2.15	0.002361	2.65	0.000178	3.15	0.00000840
0.16	0.820988	0.66	0.350623	1.16	0.100904	1.66	0.018895	2.16	0.002253	2.66	0.000169	3.16	0.00000786
0.17	0.810008	0.67	0.343372	1.17	0.098000	1.67	0.018190	2.17	0.002149	2.67	0.000159	3.17	0.00000736
0.18	0.799064	0.68	0.336218	1.18	0.095163	1.68	0.017507	2.18	0.002049	2.68	0.000151	3.18	0.00000689
0.19	0.788160	0.69	0.329160	1.19	0.092392	1.69	0.016847	2.19	0.001954	2.69	0.000142	3.19	0.00000644
0.2	0.777297	0.7	0.322199	1.2	0.089686	1.7	0.016210	2.2	0.001863	2.7	0.000134	3.2	0.00000603
0.21	0.766478	0.71	0.315335	1.21	0.087045	1.71	0.015593	2.21	0.001776	2.71	0.000127	3.21	0.00000564
0.22	0.755704	0.72	0.308567	1.22	0.084466	1.72	0.014997	2.22	0.001692	2.72	0.000120	3.22	0.00000527
0.23	0.744977	0.73	0.301896	1.23	0.081950	1.73	0.014422	2.23	0.001612	2.73	0.000113	3.23	0.00000493
0.24	0.734300	0.74	0.295322	1.24	0.079495	1.74	0.013865	2.24	0.001536	2.74	0.000107	3.24	0.00000460
0.25	0.723674	0.75	0.288845	1.25	0.077100	1.75	0.013328	2.25	0.001463	2.75	0.000101	3.25	0.00000430
0.26	0.713100	0.76	0.282463	1.26	0.074764	1.76	0.012810	2.26	0.001393	2.76	0.000095	3.26	0.00000402
0.27	0.702582	0.77	0.276179	1.27	0.072486	1.77	0.012309	2.27	0.001326	2.77	0.000090	3.27	0.00000376
0.28	0.692120	0.78	0.269990	1.28	0.070266	1.78	0.011826	2.28	0.001262	2.78	0.000084	3.28	0.00000351
0.29	0.681717	0.79	0.263897	1.29	0.068101	1.79	0.011359	2.29	0.001201	2.79	0.000080	3.29	0.00000328
0.3	0.671373	0.8	0.257899	1.3	0.065992	1.8	0.010909	2.3	0.001143	2.8	0.000075	3.3	0.00000306
0.31	0.661092	0.81	0.251997	1.31	0.063937	1.81	0.010475	2.31	0.001088	2.81	0.000071	3.31	0.00000285
0.32	0.650874	0.82	0.246189	1.32	0.061935	1.82	0.010057	2.32	0.001034	2.82	0.000067	3.32	0.00000266
0.33	0.640721	0.83	0.240476	1.33	0.059985	1.83	0.009653	2.33	0.000984	2.83	0.000063	3.33	0.00000249
0.34	0.630635	0.84	0.234857	1.34	0.058086	1.84	0.009264	2.34	0.000935	2.84	0.000059	3.34	0.00000232
0.35	0.620618	0.85	0.229332	1.35	0.056238	1.85	0.008889	2.35	0.000889	2.85	0.000056	3.35	0.00000216
0.36	0.610670	0.86	0.223900	1.36	0.054439	1.86	0.008528	2.36	0.000845	2.86	0.000052	3.36	0.00000202
0.37	0.600794	0.87	0.218560	1.37	0.052688	1.87	0.008179	2.37	0.000803	2.87	0.000049	3.37	0.00000188
0.38	0.590991	0.88	0.213313	1.38	0.050984	1.88	0.007844	2.38	0.000763	2.88	0.000046	3.38	0.00000175
0.39	0.581261	0.89	0.208157	1.39	0.049327	1.89	0.007521	2.39	0.000725	2.89	0.000044	3.39	0.00000163
0.4	0.571608	0.9	0.203092	1.4	0.047715	1.9	0.007210	2.4	0.000689	2.9	0.000041	3.4	0.00000152
0.41	0.562031	0.91	0.198117	1.41	0.046148	1.91	0.006910	2.41	0.000654	2.91	0.000039	3.41	0.00000142
0.42	0.552532	0.92	0.193232	1.42	0.044624	1.92	0.006622	2.42	0.000621	2.92	0.000036	3.42	0.00000132
0.43	0.543113	0.93	0.188437	1.43	0.043143	1.93	0.006344	2.43	0.000589	2.93	0.000034	3.43	0.00000123
0.44	0.533775	0.94	0.183729	1.44	0.041703	1.94	0.006077	2.44	0.000559	2.94	0.000032	3.44	0.00000115
0.45	0.524518	0.95	0.179109	1.45	0.040305	1.95	0.005821	2.45	0.000531	2.95	0.000030	3.45	0.00000107
0.46	0.515345	0.96	0.174576	1.46	0.038946	1.96	0.005574	2.46	0.000503	2.96	0.000028	3.46	0.00000099
0.47	0.506255	0.97	0.170130	1.47	0.037627	1.97	0.005336	2.47	0.000477	2.97	0.000027	3.47	0.00000092
0.48	0.497250	0.98	0.165769	1.48	0.036346	1.98	0.005108	2.48	0.000453	2.98	0.000025	3.48	0.00000086
0.49	0.488332	0.99	0.161492	1.49	0.035102	1.99	0.004889	2.49	0.000429	2.99	0.000024	3.49	0.00000080

$$m = \frac{\Delta H_f\,(\text{m})}{\Delta t\ (\text{month})}$$

$$t_1 = t - \frac{t_c}{2}$$

$$\Delta H_f = \frac{\alpha H_f}{1 + e} \log\left(\frac{t''}{t'}\right)$$

$m = a - b \log t_1$ [for fill heights ranging from 12 to 24 m]

$m = c - d \log t_1$ [for fill heights ranging from 24 to 30 m]

$m = e - f \log t_1$ [for fill heights larger than 30 m]

In these equations,

m is in m/mo(ft/mo).

t_1 is the median fill age, in months

In SI units, the values of a, b, c, d, e, and f

[illegible]	SI
a	0.0268
b	0.0116
c	0.038
d	0.0155
e	0.0435
f	0.0183