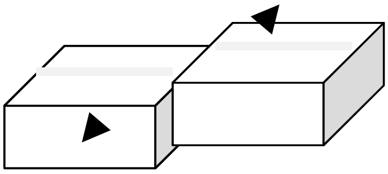
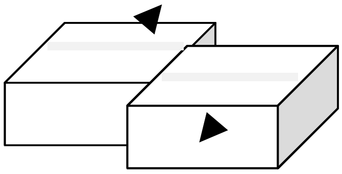
MEMORANDUM: Paper 2 – October 2007

QUESTION 1

a) Layering in igneous rocks – thin successive lava flows. (2)
b) Facies (2)
c) Lamina/Laminae (2)
d) An isocline is a fold in which the limbs dip in the same direction (1) at the same angle (1), the limbs and the axial plane are all parallel (1).
e) For a strike-slip fault (1), when one looks across it in a direction normal to the fault plane (1), the block on the opposite side moves apparently to the right (dextral) (1) or to the left (sinistral) (1)



Sinistral (2)



Dextral (2)

f) Igneous rocks (1/2): rocks that have solidified from molten material (1/2)
Sedimentary rocks (1/2): rocks formed by layering due to particles varying in density (hence differing settling rates) (1/2)
Metamorphic rocks (1/2): rocks in which the original character has been changed due to heat or igneous activity; temperature, pressure and active fluids (1/2).

[20 Marks]

QUESTION 2

a) 1. Massive rock mass condition: in which the structure in the rock mass has an insignificant effect on excavation behaviour (1)
2. Major structural influence conditions: features such as faults, dyke contacts and major joints provide surfaces on which deformation and failure may take place (1)
3. Jointed rock mass condition: well-distributed jointing systems throughout the rock mass such that the behaviour of an excavation will be in response to the "overall" rock mass (1)
4. Weathered rock and soil (1)

b) 1. Uniaxial compressive strength test of the Hangingwall, reef and Footwall rocks – this serves as a "characterisation" test – modelling input parameters. (2)
2. Triaxial test of reef material – confining strength of pillar material. (2)
3. Point load tests – increases the database of UCS values. (2)

4. Brazilian tensile strength tests - provide the tensile to compressive strength ratio, an indication of the brittleness of the rock. (2)
5. Shear strength tests - to determine the base friction angle, and possibly shear tests on natural joint surfaces (ideal for HW or FW shearing along reef contact). (2)

c) Q = RQD/Jn x Jr/Ja x Jw/SRF

RQD = 115 – (3.3 x (380joints / 60m)) = 94.1, can round up to 95 (1)

Jn = 4 (2 distinct joint sets) (1)

Jr = 0.5 (slickensided, planar) (1)

Ja = 2 (Joint filling > 1 mm) (1)

Jw = 1 (dry) (1/2)

SRF = 2.5 (One shear, fault, dyke or weakness zone) (1/2)

Q = 2.375 (1)

[20 Marks]

QUESTION 3

a) 1. Technology auditing: (1) Concerned with assessing the implementation of Rock Engineering knowledge on a mine in the context of the prevailing mining conditions: (1)

- Review support standards (1)
- Code of practice (1)
- Underground and mine plan inspections: (1/2)
  Utilisation and installation of support (1/2)
  Use of additional support where required(1/2)
  Hangingwall conditions(1/2)
  Mining layouts(1/2)
  Support quality procedures(1/2)

2. Skills auditing: (1) assesses the quality and level of Rock Engineering knowledge available on a mine. (1)

- Understanding of mine personnel, as appropriate to their position and work requirements (interviews with regard to rock engineering principles and the implementation of support) (1)
- Ability and knowledge of Rock Engineering staff is assessed. (1)
- Access of Rock Engineering staff to necessary training courses(1)
- Input from the Rock Engineering Consultant. (1)
- Level and quality of the Rock Engineering Department's technical communications with management, production and other service department personnel. (1)
- Rock Engineering content in Mine training programmes assessed for its relevance and promotion of sound rock engineering principles. (1)

b)

Load Cell on support type	Operation and complexity
Stick load cell	Mechanical/simple
Pack load cell	Mechanical/simple
Backfill load cell	Mechanical/specialised
Roofbolt load cell	Mechanical or electrical/simple

(1) Per row, except for the roofbolt - it is 2 points

[20 Marks]

QUESTION 4

a) (i) $\sigma_v = \rho gh$
$= 3120 \times 9.81 \times 180$ MPa
$= 5.51$ MPa (1)

Pillar stress $= 5.51 \text{ MPa}/(1 - 0.83)$
$= 32.41$ MPa (1)

Pillar strength = FOS x Pillar stress
$= 3 \times 32.41$ MPa
$= 97.23$ MPa (1)

Pillar strength $= K\, W_{eff}^{0.5}/H^{0.75}$
$= 80\, W_{eff}^{0.5}/1.8^{0.75}$
$97.23 = 80\, W_{eff}^{0.5}/1.55$ (1)

$W_{eff}^{0.5} = 1.89$
$W_{eff} = 3.57$ (1)

$4(10 \times b)/[2(10+b)] = 3.57$
$b = 2.17$ metres (2)

(ii) $W_{eff} = \{4(10x5)\} / \{2(10+5)\}$ m
$= 6.67$ m (1)

Pillar strength $= 80\,(6.67)^{0.5}/1.8^{0.75}$ MPa
$= 132.82$ MPa (1)

Factor of Safety = pillar strength/ pillar stress
$= 132.82 \text{ MPa}/32.41 \text{ MPa}$
$= 4.14$ (1)

b) Support resistance required $= \rho gh$ (1)
$= 3120 \text{ kg/m}^3 \times 9.81 \text{ m/s}^2 \times 3.7 \text{ m}$ (1)
$= 113.24 \text{ kN/m}^2$ (1)

Area that elongate is capable of supporting $= 270 \text{ kN}/113.24 \text{ kN/m}^2$ (1)
$= 2.38 \text{ m}^2$ (1)

c) i. To permit safe and economical mining (1)

ii. To provide a working surface for mining operations, such as in cut and fill mining (1)
iii. To improve ventilation control (1)
iv. To achieve maximum extraction of the orebody (1)
v. To benefit the environment by disposal underground of waste rock and/or tailings (1)

[20 Marks]

QUESTION 5

a) Time of the event (1)

Location of the event (x-, y- and z-coordinates) (1)

Seismic moment, M_o, and its tensor (1)

Radiated seismic energy and/or seismic stress drop (1)

Characteristic size of the event (1)

b) Sensors are placed in boreholes that extend beyond the heavily fractured ground. (1)

Sensors are paced in grout that provides a good coupling with the rock. The hole is to be filled to avoid the trapping of acoustic energy. (1)

The grout should have similar acoustic impedance. (1)

Sensors should be installed with known orientation. (1)

Sensors placed on soil, rather than bedrock, may be placed on top of a concrete mount, provided that this mount has a radius less than 1/9 of the highest frequency to be recorded. (1)

c) Any five of the following:

Finite difference method
Finite Element Method
Distinct Element Method
Fictitious Stress Method
Displacement Discontinuity Method
Direct Boundary integral Method
Keyblock Method (5)

d) Any five of the following:

Identify problem areas and the potential problem.
Design a number of potential mining strategies to alleviate the problems
Define relevant design criteria.

Develop a model that incorporates necessary detail to assess the mining strategies in terms of the design criteria.
Choose a relevant tool or tools to test the proposed mining strategies based on the model.
Perform simulations on each strategy using the model and specified design criteria.
Analyse the results of the simulations in terms of the specified design criteria.
Select a mining strategy based on the analyses, or propose new/modified mining strategies.
(5)

[20 Marks]