CHAMBER OF MINES OF SOUTH AFRICA

EXAMINATION PAPER

SUBJECT: CERTIFICATE IN ROCK MECHANICS PAPER 3.3 : MASSIVE UNDERGROUND MINING (HARD AND SOFT ROCK) **SUBJECT CODE:** COMRM**C3.3**~~E~~	**EXAMINER:** DR PJ LE ROUX **MODERATOR:** W JOUGHIN
EXAMINATION DATE: **12** OCTOBER 2017 **TIME**: ~~14:30 – 17:30~~ 3 HOURS	**TOTAL MARKS:** [100] **PASS MARK:** (60%)

Formatiert: K3, Trennen

Formatiert: K3, Trennen, Tabstopps: Nicht an -1,27 cm

NUMBER OF PAGES: 4 (incl)

THIS IS NOT AN OPENBOOK EXAMINATION – ONLY REFERENCES PROVIDED ARE ALLOWED

SPECIAL REQUIREMENTS:

1. Answer **all questions**. Answer the questions **legibly** in English.
2. Write your **ID Number** on the outside cover of each book used and on any graph paper or other loose sheets handed in.

NB: Your name **must not** appear on any answer book or loose sheets.

3. Show all calculations **and check calculations on which the answers are based.**
4. **NO** hand-held electronic calculators may be used for this exam.
5. Write **legibly** in ink on the **right hand page** only – **left hand pages will not be marked**.
6. Illustrate your answers by means of sketches or diagrams wherever possible.
7. **Final answers** must be given to an accuracy which is typical of practical conditions, However be careful not to use too few decimal places during your calculations, as rounding errors may result in incorrect answers
   NB Ensure that the correct unit of measure (SI unit) are recorded as marks will be deducted from answers if the incorrect unit is used. (even if the calculated value is correct).
8. In answering the questions, full advantage should be taken of your practical experience as well as data given.
9. Please note that you are not allowed to contact your examiner or moderator regarding this examination.
10. Cell phones are **NOT** allowed in the examination room.

QUESTION 1

In the mining industry the modified and generalised Hoek-Brown criteria for estimating the field strength of jointed rock masses are used to determining input parameters for limit equilibrium analyses and numerical modelling in rock mechanics. Answer the following questions related to the Hoek-Brown criteria.

1.1   Give the definitions for the following Hoek-Brown input parameters and typical values assigned for good, average and weak rock mass conditions:

     (a) Disturbance factor   **[3]**

     (b) Geological Strength Index (GSI)   **[3]**

     (c) m_i value   **[3]**

1.2   How would one apply Bieniawski's RMR_{76} and RMR_{89} rating values to obtain GSI values   **[4]**

1.3   Provide a basic definition for the following numerical modelling terms or input scripts and an example of a modelling application where one would apply the following:

1.3.1   Strain softening   **[4]**

1.3.2   Stress tensor   **[4]**

1.3.3   Off-reef field points   **[4]**

[25 ~~MARKS~~]

QUESTION 2

A massive tabular orebody is dipping at about 30° to 80° at a depth of 2200 m to 2500 m below surface. The mineralized zone is on average 25 m thick and 1500 m on strike. The mineralization lies between Quartzite's and an overlying Lava, 600 m in thickness. The UCS of the Quartzite's is 250 MPa and Lavas 350 MPa respectively.

It is intended to mine the orebody using open stoping, drilling upward from drilling and loading drives on the contact and using remote controlled loading.

a) Draw the mining layout in plan and section.   **[6]**

b) Describe the geotechnical investigations required to assess the stable spans which can be mined and what failures could be expected.   **[6]**

c) Describe how you would assess the stable span of the hangingwall.   **[8]**

d) How would you control the hangingwall span considering the mining ~~method.~~method?   **[5]**

                                                                  [25 ~~MARKS~~]

QUESTION 3

Assume a shale layer that is 0.8m thick, overlain by a thick quartzite beam is supported with 20mm diameter resin bolts. The diameter of the hole is 26mm, the yield strength of the steel is 480MPa and the density of the shale is 2480kg/m^3.

3.1   Calculate the yield load of the roof bolt?   **[2]**

3.2   Determine the minimum support density required to support the shale layer?   **[2]**

3.3   What will the maximum bolt spacing be for a factor of safety of 1.0?   **[2]**

3.4   Given that the resin-steel bond strength is 5MPa and the resin-rock bond strength is 2000kPa. Determine the critical bond length.   **[3]**

3.5   Discuss and show with the aid of sketches how geological structures can impact on rock mass behavior and tunnel stability in the following manners:

3.5.1 Bedding planes   **[4]**

3.5.2 Joints   **[4]**

3.5.3 Faults   **[4]**

3.5.4 Dykes   **[4]**

[25~~ MARKS~~]

QUESTION 4

With reference to the research project for the evaluation of the performance of shotcrete with and without fibre reinforcement under dynamic and quasi-static loading conditions (SIM 040204):

4.1   Name the steps in the process to determine the inputs required for the design of shotcrete.   **[6]**

4.2   What inputs are required for elastic modelling.   **[4]**

4.3   The main access ramp follows a continuous downward spiral inclined at 9^0 to access the underground workings.   Which orientations of the tunnel will experience greater stress-driven fracturing? What strategies could you suggest to the mine manager to minimise the effects of high stress concentrations? How will this benefit the operation in terms of cost, safety and productivity?   **[4]**

4.4   The rock mass characteristics should be determined for the geotechnical domain or ground control district in which the tunnel is situated. Name the important aspects to consider.
        [6]

4.5   It is important to consider not only the size of excavations, but the function and importance of an excavation. Name the important aspects to consider.   **[5]**

[25 ~~MARKS~~]
TOTAL MARKS: [100]