



EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA – CERTIFICATE IN STRATA CONTROL – METALLIFEROUS SUBJECT CODE: COMCSC EXAMINATION DATE: TIME: 14:30 – 17:30	EXAMINER: Y Jooste MODERATOR: DA Arnold TOTAL MARKS: [100] PASS MARK: (60%)
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NUMBER OF PAGES:

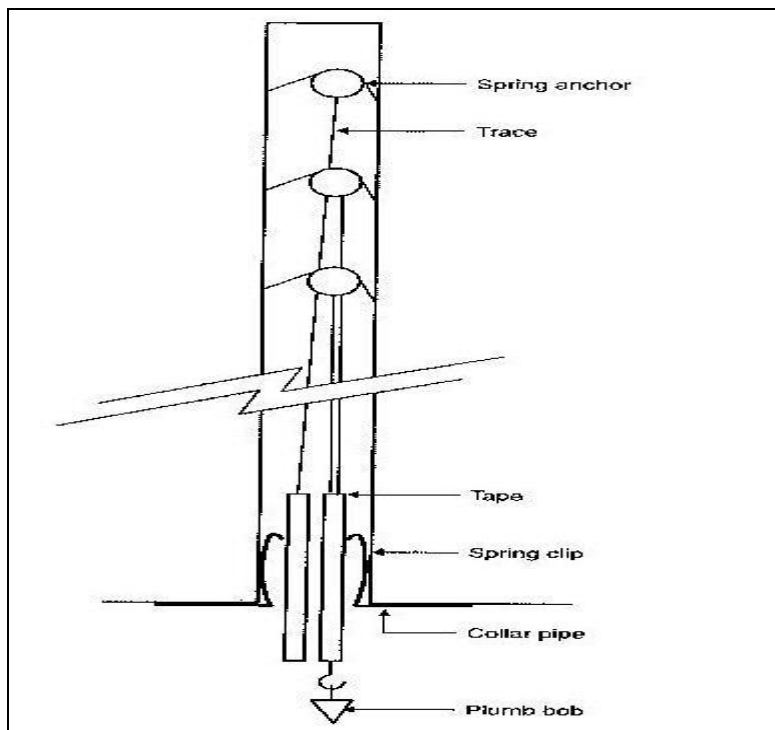
THIS IS NOT AN OPENBOOK EXAMINATION – ONLY REFERENCES PROVIDED ARE ALLOWED

SPECIAL REQUIREMENTS:

1. Answer **Questions 1, 2, 3, 4, 7 and 8** and **chose any one** of **Questions 5 or 6**. (ie. Answer seven questions in total). 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. Hand-held electronic calculators may be used for calculations. Reference notes may not be programmed into calculators.
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

- 1.1 The P-wave of a seismic event always arrives
- before
 - at the same time as
 - after
- the S-wave
- 1.2 RQD stands for
- Rock Quality Deficiency
 - Rock Quality Designation
 - Rock Quantity Designation
 - Rock Quality Deficiency
- 1.3 Determine the RQD of the rock if the core recovered from a 13m borehole is retrieved in the following core lengths:
- 3 x 24 mm
 - 4 x 30.5 cm
 - 9 x 12 mm
 - 4 x 7.5 cm
 - 6 x 350 mm
 - 14 x 5.5 cm
 - 16 x 25 cm
 - 12 x 330 mm
 - 1 x 47mm
- 93.32
 - 78.34
 - 86.77
 - 92.45
- 1.4 A body with a force F is resting on a surface inclined at 30° to the horizontal. The force S parallel to the inclined surface is:
- $F \cos 30^\circ$
 - $F \sin 30^\circ$
 - $F \tan 30^\circ$
 - $F \sin^{-1} 30^\circ$
- 1.5 Name the instrument in the next figure:



- a. Rod extensometer
- b. Wire extensometer
- c. Venier extensometer
- d. Probe extensometer

1.6 RCF is used to describe the ground conditions of

- a. Gullies
- b. Tunnels
- c. Massive stopes
- d. Tabular stopes

1.7 What is the generally accepted unit for ERR?

- a. Nm/m^2
- b. MJ/m^2
- c. Mpa
- d. Has no unit

1.8 A pillar system designed to yield must incorporate barrier pillars.

- a. True
- b. False

1.9 What is the (max) height of the tensile zone if the stope span is 210m at a depth of 310m below surface?

- a. 48.63m
- b. 86.21m
- c. 87.12m
- d. 67.32m

1.10 Minsim modelling program is a

- a. 2D discontinuum code
- b. 3D finite element code
- c. 3D displacement discontinuity codes
- d. 2D plasticity code

[10]

QUESTION 2 – Definitions

Define the following terms and where applicable give units:

- 2.1 Support resistance
- 2.2 Plasticity
- 2.3 Rock mass
- 2.4 Young's modulus
- 2.5 Intact rock

[10]

QUESTION 3 – Rock Joints and Rock Mass Ratings

- 3.1 List the 6 parameters (do not supply only abbreviations) that are used to classify a rock mass according to the Bieniawski Rock Mass Rating. (6)
- 3.2 Laubscher suggested changes to the Bieniawski Rock Mass Rating system. This system takes the basic *RMR* value, as defined by Bieniawski, and adjusts it. How did he adjust the rating system? (2)

- 3.3 A development end on a mine has intersected poor ground which has slowed advances. A 60 m long exploration diamond drill hole, with orientated drill core, has been drilled ahead of the face to gather information on expected ground conditions. You must analyze the orientated core recovered from the hole. You record a **total** of 380 joints in the core. There appears to be two distinct sets of strike joints, dipping at roughly 20 and 80 degrees respectively. While the one set is rough and undulating, the other is smooth, planar and slickensided. Traces of micaceous filling, varying in thickness from 0 – 3 mm, are visible in the joint planes. No water seems to be present. There also appears to be a 3.0-metre thick weathered dyke running through the middle of this zone, at an angle of 45 degrees.

Calculate the rock mass quality based on the Q-system, using the tables provided in appendix 1. Motivate your reason for each value chosen for use in the rock mass rating. (7)

- 3.4 Calculate the Rock Wall Condition Factor for the following parameters:
 $\sigma_1 = 40 \text{ Mpa}$ $\sigma_3 = 20 \text{ Kpa}$ $\sigma_c = 70 \text{ Mpa}$ and $F = 1.0$ (2)
- 3.5 What should the support recommendation be according to Rock Wall Condition Factor calculated in 4.4. (1)

3.6 List two reasons why rock mass classification is important? (2)

[20]

QUESTION 4 – SUPPORT

4.1 Show on a load/deformation graph the following support characteristics, namely:

- Pre-tension
- Yield load
- Brittle failure
- Energy absorption (10)

4.2 How can you pre-tension a support unit? Give an example. (2)

4.3 Give a comparison between the function of a grouted tendon and a split set. State a typical application of each. (4)

4.4 Name the two general design rules for tendon support frequently used within the mining industry for the spacing and length of tendons in tunnels. (2)

4.5 What do you understand by the term critical bond length? (2)

[20]

QUESTION 5 – ROCK BEHAVIOUR

5.1 List five points to take into consideration when designing access tunnels in medium to deep stress conditions. (5)

5.2 Show with a sketch how you would re-develop on reef in high stress conditions and indicate clearly all assumptions made. (5)

[10]

QUESTION 6– MASSIVE MINING

Define the following massive mining terms

- 6.1 Drawpoint
- 6.2 Drift
- 6.3 Ramp
- 6.4 Slot
- 6.5 Sub-level

[10]

QUESTION 7 – ROCK BREAKING

- 7.1 With the aid of a sketch, list the mode of action of explosives with reference to the shock wave and gas pressure assuming a high vertical stress. (4)
- 7.2 List two underground observations that would indicated poor blasting practise? (2)
- 7.3 What is pre-splitting and how is it used? (2)
- 7.4 List and describe one main characteristic of two types of explosives used in the mining industry. (2)

[10]

QUESTION 8

You are the appointed rock engineer on a moderately deep mine. An incident occurred on your mine that resulted in three fatalities. Initial reports from underground suggest that there was an extensive fall of ground in the face area and some of the crew members reported that they felt a seismic event. You must visit the accident scene and investigate the accident.

- 8.1 List and describe briefly five underground observations that you would make that would assist with the understanding of the accident. (8)
- 8.2 How can you verify if a seismic event was the cause of the accident? (2)
- 8.3 Underground observations indicate that bursting of the face was the main cause of the accident. What would you do to minimize the damage of a similar accident in future? (3)
- 8.4 What instruments are used to detect a seismic event? (1)

- 8.5 A report on the FOG needs to be compiled. Briefly list the headings and describe the layout of your report. (6)

[20]

TOTAL MARKS: [100]

Appendix 1

	STRESS REDUCTION FACTOR	
A	No shear, faults, dyke or weakness zone	1
B	One shear, fault, dyke or weakness zone	2.5
C	One shear, fault, dyke or weakness zone with blocky ground conditions	4
D	Curved joints or dome structure approaching a pothole, reef roll or OPL's	7.5
E	Curved joints or dome structure approaching a pothole, reef roll, OPL's with blocky ground conditions	8
F	Many faults, dyke and weakness zones.	9
G	Wide shear zone	10

	JOINT ALTERATION NUMBER	
A	Tightly healed, hard rockwall joints, no filling	0.5
B	Slight infill, coating < 1mm	1
C	Joint filling > 1 mm	2
D	Joint filling > 3 mm	4
E	Zones or bands of disintegrated or crushed filling, open joints.	8

	JOINT SET NUMBER	
A	Massive, no to few joints	1
B	One joint set	2
C	One joint set plus random joints	3
D	Two joint sets	4
E	Two joint sets plus random joints	6
F	Three joint sets	9
G	Three joint sets plus random joints.	12
H	Four or more joint sets, random, heavily jointed.	15
I	Crushed rock	20

	JOINT WATER	
A	Dry	1
B	Dripping water	0.5

	JOINT ROUGHNESS NUMBER	
A	Discontinuous joints	4
B	Rough or irregular undulating	3
C	Smooth undulating	2
D	Slickensided, undulating	1.5
E	Rough or irregular planar	1.5
F	Smooth planar	1
G	Slickensided planar	0.5