CHAMBER OF MINES OF SOUTH AFRICA

EXAMINATION PAPER

SUBJECT: CERTIFICATE IN ROCK MECHANICS 3.2 (COAL) **SUBJECT CODE:COMRMC3.2** **EXAMINATION DATE: 12 OCTOBER 2017** **TIME:** 14:30 – 17:30	**EXAMINER:** W. Mahne **MODERATOR:** L. Prinsloo **TOTAL MARKS:** [100] **PASS MARK:** 60%

NUMBER OF PAGES: 11 (Including cover page)

SPECIAL REQUIREMENTS:

1. **Answer *ALL* the questions and *READ* these requirements**
2. References other than those provided are not permitted.
3. Hand-held electronic calculators may be used.
4. Put 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.

5. **Write in ink on the RIGHT HAND SIDE of the paper only (only the right hand pages will be marked).**
6. Show all calculations on which your answers are based.
7. Illustrate your answers by sketches of diagrams wherever possible.
8. In answering these questions, full advantage should be taken wherever necessary of your practical experience as well as of the data given.
9. Answers must be given to **an accuracy that is typical of practical conditions**.
10. In presenting answers, candidates are encouraged to use **tabulations** and **diagrams** or answers must be written in **bullet** points – **No long paragraphs**.
11. Cell phones are **NOT** allowed in the examination room

QUESTION 1

You are the appointed Rock Engineer at a mine in the Witbank Coalfields area. A new block of ground is planned to be mined adjacent to an area that are currently being mined. The number 4 seam will be mined.

- Depth of mining (Section) ranges from ≈ 17 m to ≈ 80 m.
- The immediate roof of the seam consists of laminated shales.
- The number 2 seam was mined out in the mid 60's at a mining height of approximately 2.5 m.
- Interburden between the Number 2 and 4 seams is on average 30 m.

Use a solid design methodology when doing the design for the mining of this block of ground.

Make reasonable assumptions where necessary. Clearly state up front all assumptions made.

In the area where the borehole (Appendix 1) information was obtained from for the Number 4 seam the following must be done:

a. Calculate the mining parameters of the Number 2 seam if a Factor of Safety of approximately 1.6 was maintained. Average bord widths at the time of mining was 6.5 m.

[3]

b. Using the Van der Merwe 2013 Overlap Reduction Methodology do a pillar design for the long-term excavations as well as the production panels for the area where the borehole information was obtained. Take into account that stooping will be planned for the Number 4 seam.

[10]

c. Give the criteria for the NEVID stooping method.

[3]

d. With the help of an annotated diagram explain the NEVID method of stooping, which would include the additional support requirements, the cutting sequence of the pillars and the sequence of pillar extraction.

[9]

[25]

QUESTION 2

Fall of ground history is given in the table below for similar conditions encountered while mining the Number 4 seam in a different area. Geotechnical analysis indicated that the roof material would behave similar in the area to be mined. Dry drilling will be done.

When designing the support use acceptable values for the rockmass parameters, support systems etc. **State all assumptions (all assumptions must be reasonable).**

FOG Data							
4	2.4	0.3	0.2	0.5	2.5	0.3	1
1	0.25	0.5	0.2	0.8	0.5	0.6	0.3
0.05	0.25	0.3	0.4	0.3	0.7	2	1
0.06	0.1	0.5	0.35	0.3	1	1.5	
0.1	1	0.5	2	0.15	0.3	0.8	

a. State and justify the support design methodology will be used to support the roof of the underground mining operations. [2]

b. State the design criteria for the support system. [5]

c. Design the support system for a 7.2 m bord width. [10]

d. Describe and give examples of active and passive support used in the underground coal mining industry.
[3]

e. For a bolt length determined above, complete the table below with the appropriate dimension for full column resin grouted roof bolts. Show all calculations and state all assumptions.

1. Bolt Ɵ	Hole Diameter mm				Hole length	Resin Capsule Ɵ	Required. Length of Resin Capsule
	Collar	Mid	Back	Average			
18mm	25.3	25.0	24.7	25.0			
20mm	26.4	25.2	25.0	25.3			

[5]

[25]

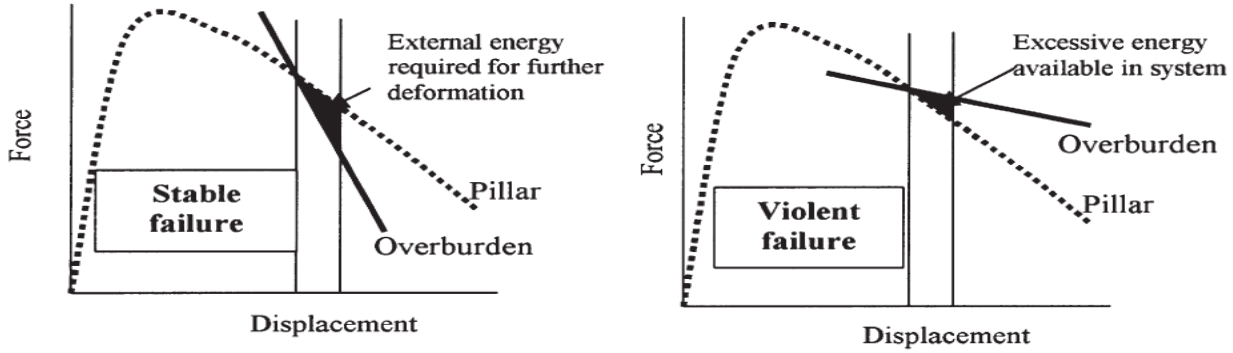
QUESTION 3

Longwall mining is considered at a depth of approximately 200 m below surface.

a. Give a brief discussion on the factors that you need to consider during the design of a Longwall panel.

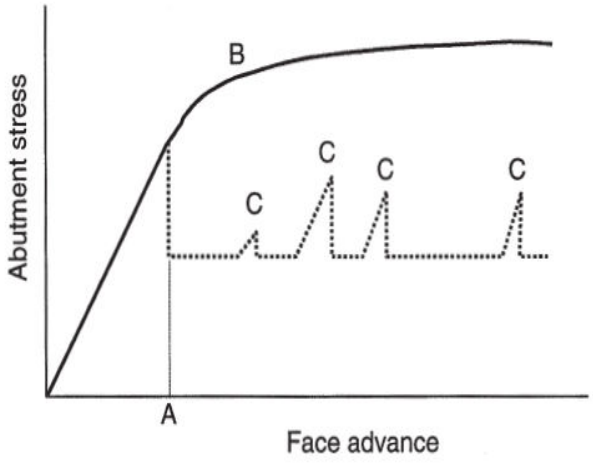
[10]

b. Explain on the hand of the bottom diagrams the failure mechanism within the face roof area of a Longwall face during stationary and very slow movement of the shearer. Assume the goaf is approximately 5m from the rear of the chock line.



[5]

c. Explain on the hand of the following diagrams the failure mechanism during a Longwall goafing process.



[5]

[20]

QUESTION 4

An opencast colliery wishes to increase extraction of a 4.0m thick coal seam by highwall mining methods. It can be assumed that the final cut is approximately 1.0km long.

As the appointed Rock Engineer, prepare a design document that could safely extract a depth of 300m of coal.

The answer must be presented in bullet point format

a. Compare and contrast the benefits of Augur Mining vs Plunge Mining

[4]

b. Discuss how the highwall should be prepared for highwall mining

[2]

c. The width of the cutter drum selected is 3.5m wide. Provide a proposed design for a highwall mining layout that is both productive and stable.

[14]

[20]

QUESTION 5

The following questions are pertaining to the designing and mining of an opencast strip mining operation:

a. State and explain the different mining criteria used in the design and mining of the operation with regards to single and multiple bench, spoils, slopes, virgin and previously mined ground etc. What would be considered under different circumstances?

[6]

b. Give a brief explanation of the different failure mechanisms, their contributing factors, consequences, monitoring and remedial actions.

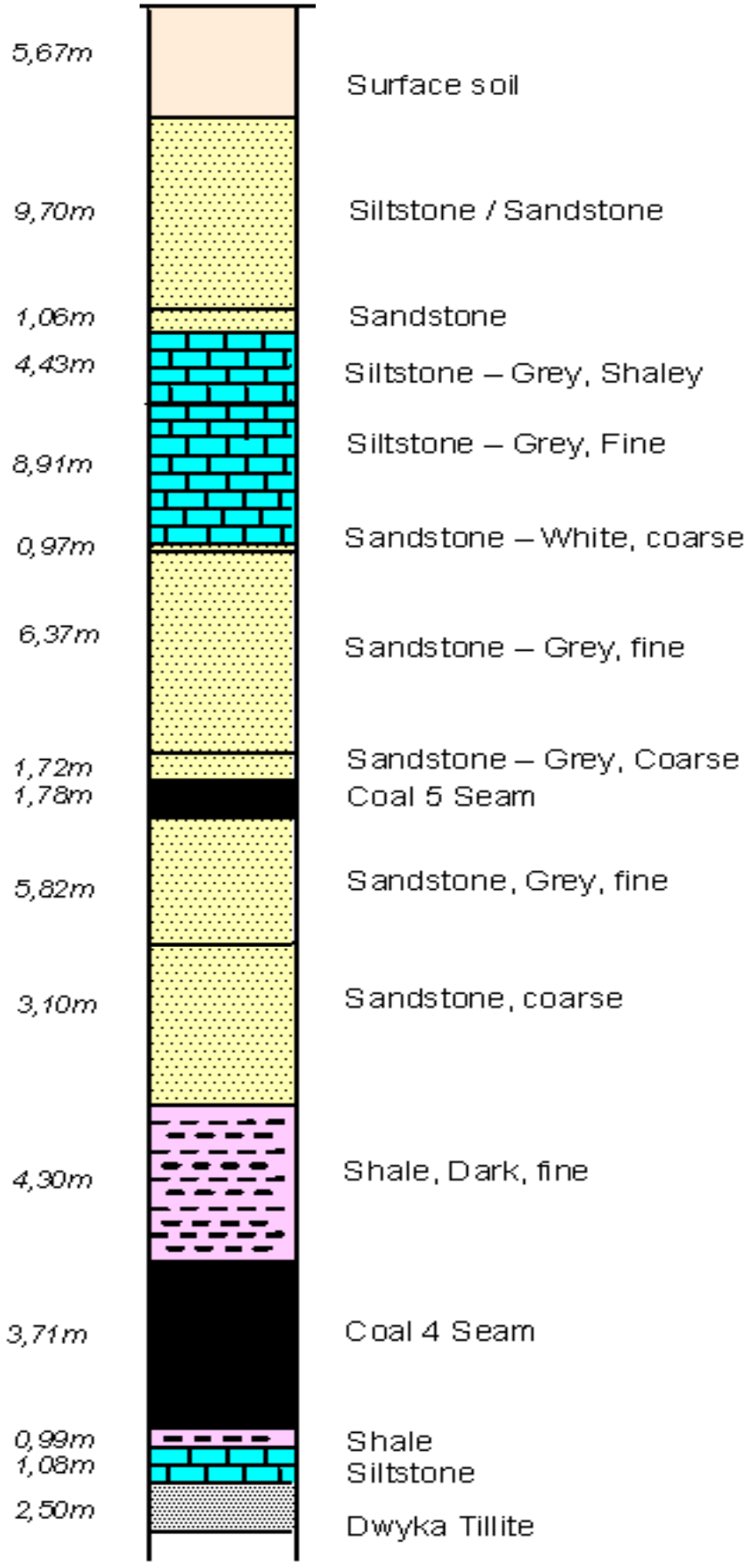
[4]

[10]

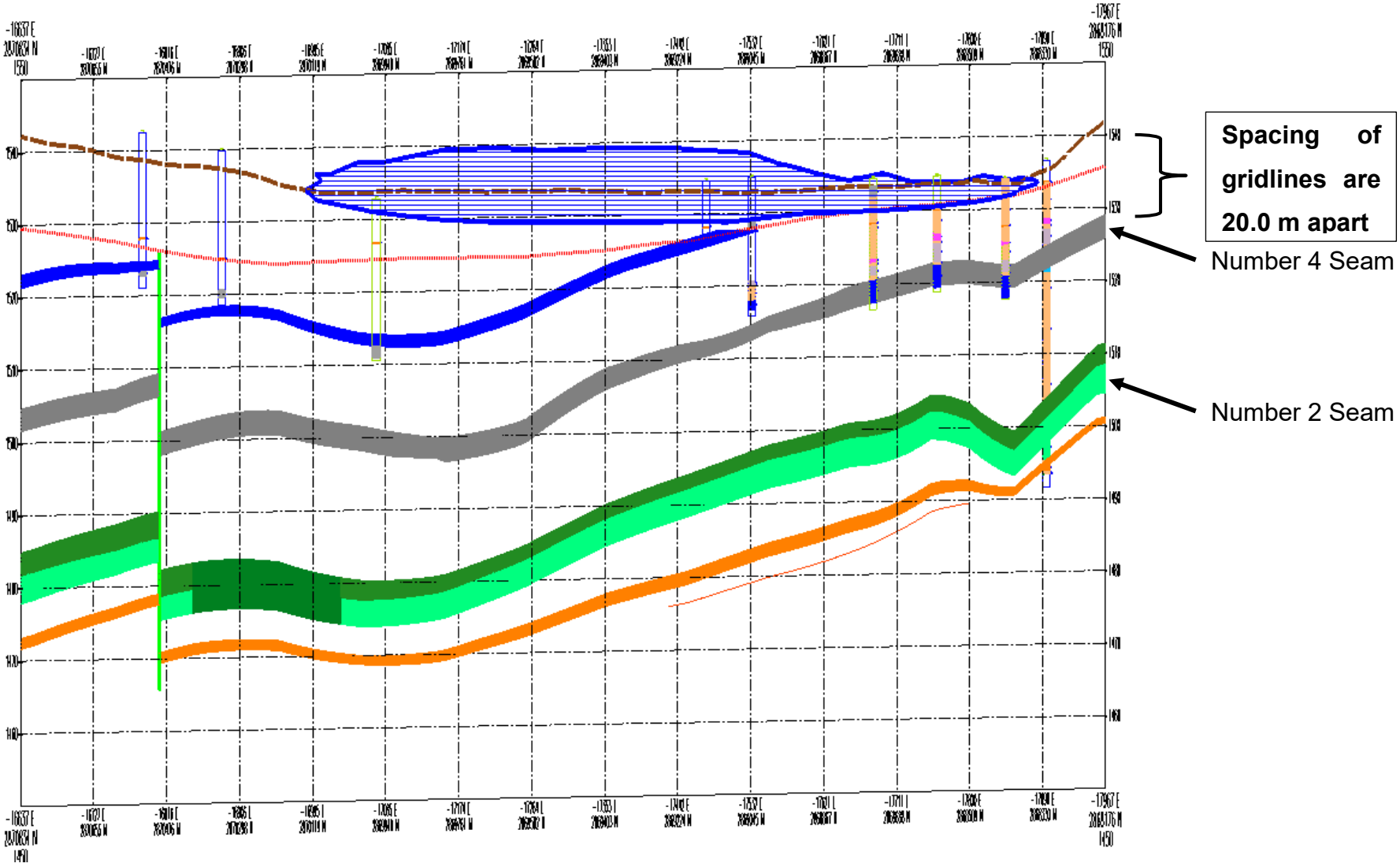
TOTAL MARKS:100

Appendix A

Borehole log of number 4 seam



Section Plan



Equation Sheet

Candidates may find some of the following equations useful, although other equations may also be used.

Pillars

$$\sigma = 7{,}2\frac{w^{0{,}46}}{h^{0{,}66}}$$

$$\sigma = 5.47\frac{w^{0{,}8}}{h}$$

$$\sigma = 6.61\frac{w^{0{,}5}}{h^{0.7}}$$

$$\sigma = 4{,}3\left(0{,}64 + 0{,}36\frac{w}{h}\right)$$

$$\sigma = 3.5\frac{w}{h}$$

$$\sigma = k\frac{R_0^b}{V^a}\left\{\frac{b}{\varepsilon}\left[\left(\frac{R}{R_0}\right)^{\varepsilon} - 1\right] + 1\right\}$$

$$\sigma = \frac{.0786}{V^{0.0667}}\left\{R^{2.5} + 181.6\right\}$$

$$w_e = \frac{4A}{C}$$

$$SF_{cm} = SF\left(1 + \frac{0.6}{w}\right)^{2.46} \quad SF_{cm} = SF\left(1 + \frac{0.6}{w}\right)^{3}$$

$$SF' = SF\left(\frac{w - \Delta w}{w}\right)^{2.46} \quad SF' = SF\left(\frac{w - \Delta w}{w}\right)^{3}$$

$$SF'' = \left(\frac{h}{h + \Delta h}\right)^{0.66} \quad SF'' = \left(\frac{h}{h + \Delta h}\right)$$

$$Load = \frac{\left[.025(H - T) + .03T\right]C_1C_2}{w_1w_2}$$

$$e\% = 100\left[\frac{h_m}{h_s}\left(1 - \frac{w^2}{C^2}\right)\right]\frac{W}{W + P}$$

$$E_{cp} = \frac{0{,}562w_e}{h} - 2{,}293$$

$$R = m\left[\frac{h}{T}\right]^x$$

$$d = w - \left[0{,}00714 S_{\min} HhC^2\right]^{0{,}333}$$

$$S_{\min} = 0.4$$

$$T = \left[\frac{d}{mh^x}\right]^{\frac{1}{1-x}}$$

Region	m	x
Vaal Basin, Klip River and South Rand	1,3888	0,804
Witbank No 2 and 4 Seams	0,1624	0,8135
Witbank No 5 Seam	0,105	-0,3061

Roof Support

$$\sigma_t = \frac{qB^2}{2t^2}$$

$$q = \rho g(t_s + t_w)$$

$$\sigma_t = \frac{fq_c s^2}{2t^2}$$

$$s = 1.414 t_{\min}\sqrt{\frac{\sigma_{tm}}{fq_c}}$$

$$q_c = q_l + \frac{q_u E_l - q_l E_u}{E_l + E_u}$$

$$l_a = \frac{\rho g s^2 t_w}{\tau_c \pi d_h} + .05$$

$$\eta = \frac{SF\rho gt}{P_d}$$

$$\sigma_{ts} = \frac{4W_b}{\pi d_b^2}$$

$$l_c = \frac{l_a\left(d_h^2 - d_b^2\right)}{\left(d_h - .002\right)}$$

$$t_{sb} = \frac{fk\rho gB^2}{2\sigma_{tm}}$$

$$\tau_b = \frac{3k\rho gB}{4}$$

$$\tau = C_c + C_b + \frac{F_b}{s_b^2}\tan\phi$$

$$F_b = \frac{s}{\tan\phi}\left[\frac{3\rho gkBs}{4} - \sigma_r d_h\right]$$

$$F_T = F_b \rho g k t_{sb} s^2$$

$$l_a = \frac{F_T}{\pi d_h \tau_c}$$

$$\eta = \frac{\gamma B^4}{32Et^2}$$

$$\sigma_s = \frac{4F_T}{\pi d_s^2}$$

$$\beta = \arctan\left(\frac{L/2}{\eta}\right) - \arctan\left(\frac{\eta}{L/2}\right)$$

$$R = \frac{L/2}{Cos\beta}$$

$$d\theta = \frac{\pi}{2} - \arctan\left(\frac{R - \eta - h_l}{L/2 - d}\right)$$

$$S = t_l d\theta$$

$$\sigma_r = \frac{\tau_l S_b}{d_b}$$

$$\varepsilon_r = \frac{\sigma_r}{E_r}$$

$$S_r = \varepsilon_r\left(d_h - d_b\right) + R_s$$

$$SSF = \frac{S}{S_r}$$

Subsidence

$$S_{m,he} = 0{,}39h\left(\frac{W}{H}\right)^{0{,}32}$$

$$S_{m,pf} = 0.1h_e$$

$$h_e = he$$

$$S_x = \frac{S_{\max}}{2}\left[\tanh\left(\frac{7x}{W} - 1{,}645\right) + 1\right]$$

$$L_c = 2T\sqrt{k + \frac{\beta}{D}} + 2(H - D)\tan\theta$$

$$\beta = \frac{c - b\gamma d}{\gamma_m \tan\phi} - \frac{kl}{2}$$

$$\beta = \frac{1.53}{\gamma_m} - 0.8$$

$$\gamma_m = \gamma_s \frac{D - T}{D} + \gamma_d \frac{T}{D}$$

$$\gamma_m = 0.025\frac{D - T}{D} + 0.03\frac{T}{D}$$

$$T_m = 21.6S_m + 7$$

$$\varepsilon_{m+} = 4.2S_m + 1.7$$

$$\varepsilon_{m-} = -9.1S_m - 2.8$$

Physics

$$E_k = \frac{1}{2}mv^2$$

$$v_i = \sqrt{2gd}$$