UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA MINING ENGINEERING
SUBJECT	:	**TECHNICAL SERVICES**
CODE	:	**MTL3211**
DATE	:	**13 NOVEMBER 2017**
DURATION	:	3 HOURS (08H30-11H30)
TOTAL MARKS	:	100 Marks
WEIGHTING	:	60% YrMark

EXAMINER	:	WB MOTLHABANE
MODERATOR	:	T. MATAMBELE

INSTRUCTIONS

1. ANSWER ALL QUESTIONS

2. UNDERLINE AFTER EACH QUESTION AND LABEL THE QUESTIONS AS LABELLED IN THE PAPER

3. NO CELLPHONES (SWITCH-OFF)

4. DO NOT USE TIPPEX.

QUESTION ONE

1. If 12 000m3 of air at 21 ^{0}C is heated to 31^{0}C at a constant pressure, what will its volume be? **(5)**
2. A certain mass of air has a volume of 12 000 m3 on the surface where the barometric pressure is 90kPa. What would the volume of this same mass of air be at the bottom of a mine where the pressure is 125kPa? **(5)**
3. Mention at least five factors that can influence the air flow resistance in a duct and/or in an air way. **(5)**
4. Describe fully the properties and characteristics of methane gas. **(5)**

[20 Marks]

QUESTION TWO

1. Describe ways to deal with coal dust explosion risk in the mine.**(5)**
2. A centrifugal exhaust fan will be installed in a 760mm diameter ventilation column. The column length will be 600m with a friction factor of 0,0037Ns^2/m^4. The fan will be operating at a density of 1.4 kg/m^3. The fan test data tabulated below was recorded at an air density of 1,4kg/m^3.

   i. Plot the fan curve and column resistance curve and determine the fan operating point. Show the table with all calculations. Use the graph paper attached. **(5)**

   ii. New technology is available to use a HDPE column with a friction factor of 0,0015Ns^2/m^4. Draw the new resistance curve and determine the new operating point.**(5)**

   iii. Comment on the stall characteristics of the fan and the most viable option to be taken (ignore cost of the installation). **(5)**

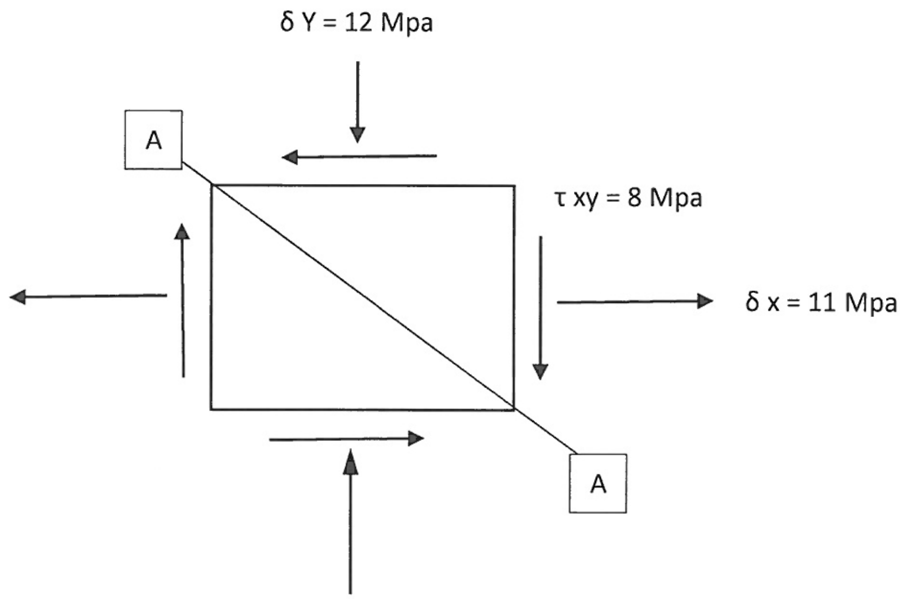
Fan quantity (m^3/s)	Fan Pressure (Pa)
4	4 800
6	4 440

8	4 620
10	4 280
12	3 500
14	2 200
16	20

[20 Marks]

QUESTION THREE

1. Given that negative stresses are tensile, positive stresses are compressive and that the negative shear stresses are anticlockwise consider the diagram below and answer the questions that follow;



i. Using Mohr circle determine the minor and major principal stresses and their directions. **(8)**

ii. The maximum shear stress and its direction. **(2)**

iii. Determine the shear strength of the plane A-A. **(5)**

iv. If Θ = 50 degrees, determine if the plane A-A will be stable, given that the cohesion of the plane is 3Mpa, friction angle of the plane is 23 degree. **(10)**

2. Discuss at least six (5) physical factors in a mining excavation that correlate with the magnitude of Energy Release Rate. **(5)**

[30 Marks]

QUESTION FOUR

1. A gold mine panel has the following;

   Modulus of rigidity y= 33 GPa

   Mining height = 1.2m

   Poisson ratio = 0.3

   Depth below surface = 2000m

   Rock density = 2700 t/m^3

When the span is 10m and mine pole is installed 1.5m from the face.

Calculate the stresses 5m ahead and on the face when the mine pole is 1.0m in length. **(15)**

2. Discuss four (4) basic causes of rock mass instability. **(8)**
3. Explain the influence of the size of the excavation has on its stability. **(2)**
4. Explain the difference between Energy Release Rate and Excess Shear Stress. **(5)**

[30 Marks]

[TOTAL MARKS 100]

lecture

Moderator

MTL3211 – MINING TECHNICAL SERVICES

SOME USEFUL FORMULAE

1. $\sigma_v = 0{,}025(H - D) + 0{,}03D$

2. $Load = \dfrac{25HC^2}{w^2}$

3. $Load = \dfrac{25[(H - T) + 30T]C^2}{w^2}$

4. $Load = \dfrac{25HC_1C_2}{w_1w_2}$

5. $Strength = 7\,176\dfrac{w^{0{,}46}}{h^{0{,}66}}$

6. $Strength = 7\,176\dfrac{w_e^{0{,}46}}{h^{0{,}66}}$

   $w_e = \dfrac{4 \times Pillar\ area}{Pillar\ circumference}$

7. $SF = 288\dfrac{w^{2{,}46}}{HC^2h^{0{,}66}}$

8. $\sigma_t = \dfrac{\gamma L^2}{2t}$

9. $\sigma_t = \dfrac{3\gamma L^2}{t}$

10. $\eta = \dfrac{\gamma L^4}{32Et^2}$

11. $\eta = Deflection\ (M)$

    $E = Young's\ Modulus\ (Pa)$

12. $\dfrac{F}{A_T} = \rho g b$

13. $S_z = \dfrac{2(1 - v)q}{G} \times \sqrt{L^2 - X^2}$

14.

L	S_{Ave}
L < L_C	$\frac{\pi(1-v)Lq}{2G}$
L > L_C	$0,79\,x\,S_m$
L = ∞	S_m

15.

L	ERR
L < L_C	$\frac{\pi(1-v)Lq^2}{2G}$
L > L_C	$0,79\,x\,S_m\,x\,q$
L = ∞	$S_m\,x\,q$

16.

17. $L_c = \frac{S_m G}{2(1-v)q}$

18. $\sigma_y = \frac{qX}{\sqrt{X^2 - L^2}}$

19. $\sigma_x = q(k-1) + \frac{qX}{\sqrt{X^2 - L^2}}$

20. $\sigma_{RMS} = q\sqrt{2\pi\frac{L}{S_m}} = 2{,}51q\sqrt{\frac{L}{S_m}}$

The distribution of stresses around the hole is given by the following equations.

$$\sigma_r = \frac{1}{2}q(1+k)\left(1-\frac{R^2}{r^2}\right) - \frac{1}{2}q(1-k)\left(1-\frac{4R^2}{r^2}+\frac{3R^4}{r^4}\right)\cos 2\theta$$

$$\sigma_\theta = \frac{1}{2}q(1+k)\left(1+\frac{R^2}{r^2}\right) + \frac{1}{2}q(1-k)\left(1+\frac{3R^4}{r^4}\right)\cos 2\theta$$

$$\tau_{r\theta} = \frac{1}{2}q(1-k)\left(1+\frac{2R^2}{r^2}-\frac{3R^4}{r^4}\right)\sin 2\theta$$

where;

σ_r, σ_θ and $\tau_{r\theta}$: radial, tangential and shear components of the stress in polar co-ordinates, respectively.

R: radius of the hole (m),

r: the radial distance from the centre (m), and

θ: the angle (°) measured from the positive x-axis (horizontal) in the anti-clockwise direction.

21.

$$ESS = |\tau_i| - \tau_s$$
$$\tau_s = C_o + \sigma_n tan\phi$$

22.

$\tau_i = Shear\ stess\ induced\ on\ plane$
$ESS = Excess\ shear\ stress$
$\tau_s = Shear\ strength\ of\ plane$
$C_o = Cohesive\ strength\ of\ plane$
$\sigma_n = Normal\ stress\ on\ plane$
$\phi = Friction\ angle\ of\ plane$

VENTILATION

23. $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

24. $P_1V_1 = P_2V_2$

25. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

26. $V = \frac{RT}{P}, \rho = \frac{1}{V}$

27. $p = RQ^2$

28. $p = \frac{KCLQ^2}{A^3} \times \frac{\rho}{1,2}$

29. $Q = vA$

30. $R = \frac{KCL}{A^3} \times \frac{\rho}{1,2}$

31. $A = 1,2Q\sqrt{\frac{\rho}{p}}$

32. $\%CH_4 = \frac{Q_{CH_4}}{Q_{CH_4} + Q_{Air}} \times 100$

33. $Q = \frac{Q_1 \times 10^6}{MAC - N} - Q_1$

34.

Series	
Volume	$Q_{Total} = Q_1 = Q_2 \ldots$
Resistance	$R_{Total} = R_1 + R_2 \ \ldots$
Pressure	$p = RQ^2$
Parallel	
Pressure	$p_{Total} = p_1 = p_2 \ldots$
Resistance	$\frac{1}{\sqrt{R_{Total}}} = \frac{1}{\sqrt{R_1}} + \frac{1}{\sqrt{R_2}} + \ \ldots$
Volume	$Q = \sqrt{\frac{p}{R}}$