T2180(E)(N21)T
NOVEMBER 2002

DEPARTMENT OF EDUCATION

ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: MINES AND WORKS

(8190306)

EXAMINER:
Commission of Examiners
MODERATOR:
Commission of Examiners

21 November (X-Paper)
09:00 - 12:00

Requirements: Graph paper.
Programmable calculators may NOT be used.

NOTE: If you answer more than the required number of questions, only the required number of questions will be marked. All work you do not want to be marked, must be clearly crossed out.

INSTRUCTIONS

1. This is NOT an open -book examination. Candidates are NOT allowed to use any notes, textbooks or reference work during the examination.

2. Draw a line below each completed question.

3. Answers must be clearly and correctly numbered. Answers written in pencil will not be marked. Illegible handwriting will not be marked.

4. Examination results will be disqualified if the candidate has not been accepted by the Commission of Examiners prior to the examination.

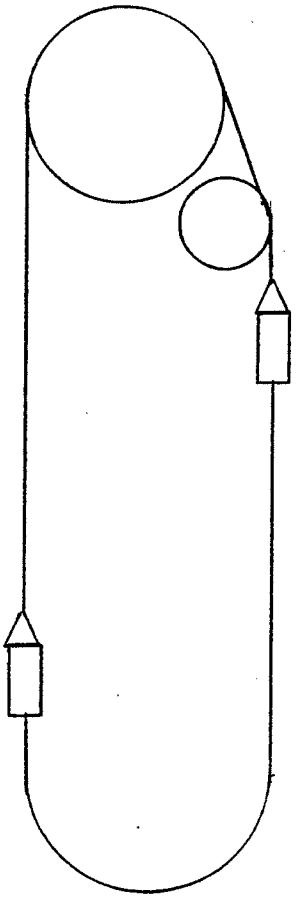
5. Candidates arriving 30 minutes late, will not be allowed to sit for the examination. No candidate writing the examination may leave the examination room before one hour after commencement has passed.

6. Show ALL calculations.

SECTION A (COMPULSORY)

QUESTION 1

A second-hand Koepe winder that winds minerals, is to be installed in a subvertical shaft. The driving sheave is too small for the width of the compartments, but the problem could be solved with a deflection sheave as shown in the sketch. The tail rope runs in a free loop at the bottom and excessive sideways movement is contained with wooden blocks.



DATA OF THE INSTALLATION:

Winding depth	1 500 m
Maximum winding speed	15,25 m/s
Mineral load ✓	18,15 t
Mass of each skip ✓	17,18 t
Diameter of driving sheave	5,95 m
Contact angle of driving sheave	170°
Moment of inertia of rotating parts	120 000 kg m^2
Mass of a head rope (4 x rope)	10,91 kg/m

PTO

Mass of a tail rope (4 x ropes)	10, 91 kg/m
Total length of head and tail ropes	1 540 m
Coefficient of friction of driving sheave	0,2
Diameter of brake race	6,25 m
Braking force of each brake shoe (2 x shoes)	980 kN
Degree of protection (DOP) (minimum)	1,4

(Directive C2, Revision 1, 13 December 1996, Department of Minerals and Energy)

Determine for a normal winding cycle the available stopping distance - as required by Directive C2 - from the stopping point, where the emergency brake would come on if the speed controller fails at the end of the full speed zone. Ensure that the emergency deceleration would not cause slip at the driving sheave wheel. Assume a friction force of 10 kN for each conveyance. [20]

QUESTION 2

2.1 A 5 MW, 6,6 kV, 0,85 power factor ventilation fan, which is installed at the end of a 30 km, 33 kV transmission line, draws full load. The fan is supplied through a 15 MVA, 33/6,6 kV transformer with an impedance of 2,5 + j7,5 Ω, reffered to the primary side. The impedance of the line per kilometre is 0,12 + j0,4 Ω.

Give a solution to maintain the fan voltage at 6,6 kV if the maximum sending end voltage is limited to 34 kV. (12)

2.2 Discuss the safety precautions that should be applied to replace an insulator on a 33 kV transmission line that runs parallel with another line. The broken insulator is 8 km from the isolating switch. (8)
[20]

QUESTION 3

In the directive on 'The Guideline for the compilation of a mandatory Code of Practice on Trackles Mobile Machinery', issued by the Chief Inspector of Mines, reference number DME 16/3/2/2_A2, dated 3 May 2000, enumerate the aspects to be addressed in the mandatory Code of Practice by the mine with regard to:

3.1 Brakes
3.2 Maintenance
3.3 Design of excavations and roadways [20]

TOTAL SECTION A: 60

SECTION B: Answer only TWO of the five questions.

QUESTION 4

4.1 A fan which ventilates a small mine runs at 500 r/min, and the air flow is measured at 150 m^3/s when the pressure developed across the fan is 0,85 kPa. The natural ventilation pressure of the mine is 0,40 kPa. The mine requires only 100 m^3/s air flow on Sundays and the fan is to be slowed down to meet the requirement. The efficiency remains at 75%.

4.1.1 Determine the new speed required for Sundays.

4.1.2 Calculate the annual savings in electricity costs if the tariff is R0,21/kWh.

4.1.3 Comment on any savings in the maximum demand. (14)

4.2 Discuss the main objectives of ventilation in a workshop, stope or any working place underground in a mine. (6)
[20]

QUESTION 5

5.1 A 500 mm wide, 6-ply trough conveyor belt running at 1,8 m/s is required to deliver 180 t/h crushed stone over a horizontal distance of 100 m with a lift of 20 m. The belt is driven by the head pulley and the tension is maintained with a gravity take-up after the head pulley. The angle of lap is 210°, friction coefficient of the head pulley is 0,23, the tension for this belt is not to exceed 8 kN/m width/ply and 10% of the delivered power is absorbed by friction.

5.1.1 Calculate the power required to drive the belt.
5.1.2 Calculate the mass of the gravity take-up.
5.1.3 Comment on devices preventing run back. (10)

5.2 From the Code of Practice on 'The safe use, operation and inspection of man-riding belt conveyors' SABS 0266: 1995, state the requirements with regard to:

5.2.1 Safety device
5.2.2 Responsibilities (10)
[20]

QUESTION 6

6.1 The run-off water from a slime dam is pumped from a large pan to the evaporation pond through a straight pipeline 2 km long, 225 mm inside diameter, followed by a 1 km, 175 mm inside diameter pipe. The height of the pond above the pan is 6 m. The pump runs at 900 r/min and has a performance curve as given below. The friction factor for the pipe is 0,007.

Head (m)	22	22	22	21,9	21,4	20,7	20	18,7
Flow (ℓ/s)	0	10	20	30	40	50	60	70
Efficiency (%)	0	30	47	60	64	66	64	63

6.1.1 Calculate the power consumption of the pump.

6.1.2 A second similar pump is connected in series just after the first pump to pump away the additional water during periods of high rainfall. The second pump should run at the highest allowable speed to handle the higher volumes.

6.1.2.1 Calculate the maximum speed of the second pump given that it is limited by the 600 kPa rating of the pipeline keeping the speed of the first pump constant.

6.1.2.2 Calculate the power drawn by each pump when operating in series at the above point. [14]

NOTE: Write your examination number on the graph and hand it in with the answer script.

6.2 State the cause of unbalanced force on a single inlet impeller and discuss preventative measures. (6)
[20]

QUESTION 7

7.1 Explain what is meant by the zoning of hazardous location as contemplated in SABS 0108, revised in 2001, The classification of hazardous locations and the selection of apparatus for use in such locations. (6)

7.2 A fully equipped BASEEFA certified underground flameproof enclosure has been imported for use in a hazardous location in a fiery mine. What is the procedure to be followed by the engineer before such enclosure may be installed and operated in that mine? (4)

7.3 Two-way radios with the following specifications/particulars are to be used in a coal mine. Will they be safe for this application? Motivate your answer clearly by considering the information below.

SABS certification for propane gas:

- Ignition temperature: 465°C
- Higher explosion limit: 9,5%
- Lower explosion limit : 2,0%

Marking on nameplate of radio:

Output power: 1 watt radiated power
Ex ib IIA T4
SABS M/V805 X (10)
[20]

QUESTION 8

8.1 A two-stage reciprocating compressor takes in 140 m^3/min of air at a pressure of 85 kPa and delivers it at a pressure of 700 kPa. The pressure in the intercooler is 240 kPa and the temperature of the air is reduced in the intercooler to the same as the intake air. The law of compression is $PV^{1,3} = C$. The overall efficiency of the compressor is 72%.

Calculate:

8.1.1 The power of the motor required to drive the compressor
8.1.2 The amount of heat removed from the air in the intercooler (10)

8.2 State the causes and preventative measures of explosions in the delivery side of reciprocating air compressors. (10)
[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100

PLANT ENGINEERING: MINES AND WORKS

FORMULAE AND CONSTANTS

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

$$= I(R\cos\phi + X\sin\phi)\,V$$

$$f = 3{,}242x\frac{flQ^2}{gd^5}$$

$$f = \frac{4flv^2}{2gd}$$

$$V = I(R + jX)\,V$$

$$Work = \frac{1}{k}xP_1V_1((\frac{P_2}{P_1})^k - 1)\,W \qquad with \qquad k = \frac{n-1}{n}$$

$$Work = \frac{1}{k}xP_1V_1\log_e((\frac{P_2}{P_1})^k - 1)\,W \qquad with \qquad k = \frac{n-1}{n}$$