This is NOT an OPEN-BOOK EXAMINATION.

Candidates are NOT allowed to use any notes, textbooks, references or cell phones during the examination.

This question paper consists of 7 pages and an information page.
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 AND INFORMATION

1. Answer ALL the questions in SECTION A and answer only TWO questions in SECTION B.

2. Read ALL the questions carefully.

3. Number the answers correctly according to the numbering system used in this question paper.

4. Rule off across the page on completion of each question.

5. Answers written in pencil will NOT be marked.

6. Examination results will be disqualified if the candidate had not been accepted by the Commission of Examiners PRIOR to the examination.

7. 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 elapsed.

8. Programmable calculators must NOT be used by any candidates.

9. Show ALL the calculations.

10. Write neatly and legibly.
SECTION A (COMPULSORY)

Answer ALL questions in this section.

QUESTION 1

The two-sheave wheels in a men-material sub-vertical shaft, equipped with an AC double drum winder, have to be replaced. The appointed engineer specified that the new rim design be heavier to extend the life of the sheave wheels. During an inspection six months later, he noticed severe wear on the crown of the rope wires on the sheave wheels whilst the winder is decelerating.

1.1 Determine the cause of the excessive wear from your calculations.

1.2 Present a practical solution to the problem.

WINDING

Full speed 10 m/s
Winding distance 400 m
Mass of empty cage 5 t
Pay load 3,5 t
Rope mass 5,823 kg/m
Rope diameter 37 mm
Average deceleration 1,5 m/s²
Creep speed 0,5 m/s
Distance BC 1,2 m
Diameter of new sheave wheel 2,4 m
Inertia of new sheave wheel 25 000 kg m²
Friction factor between rope and sheave wheel 0,25 contact angle 100°
Distance between highest stopping point and the sheave wheel 7 m
QUESTION 2

2.1 You are the Reg. 2.13.3.1 appointed engineer on a high production shaft. During the morning, while you are still on surface, you experience a total Eskom power failure in the district. Initial, unconfirmed reports say that the outage could last as long as three days. Nobody in the vicinity has power to assist with ring feeds and there is no emergency generator available. Your engineering staff was busy with shaft examination at the time of the black-out and you have people stranded 30 m above the closest station. A full morning shift is also underground.

2.1.1 Describe, in chronological order, the steps you will take to ensure the safety of your staff, getting the underground shift to surface, while maintaining the critical equipment and services in the shaft.

2.1.2 You do receive limited power during the early evening. How will this affect your activities?

2.1.3 How do you manage hoisting operations during the evacuation period?

2.2 What are the effects of, and dangers that you would experience in a typical domestic reticulation system, if the neutral wire on the load side of the reticulation falls away? The neutral wire is not earthed solidly on the load side of the transformer.

QUESTION 3

You are the Reg. 2.13.3.1 appointed engineer on a shaft and are requested by the manager to draw up a shaft examination procedure. This procedure should detail the type of inspection required, the method used to determine the condition of the components in the shaft, the frequency and criteria against which the persons conducting the examination should evaluate the shaft.

TOTAL SECTION A: 60
SECTION B

Answer TWO of the six questions in this section.

QUESTION 4

4.1 A 500 V shunt motor-connected to a 500 V DC supply - was replaced with a similar motor but was found to run hotter and slower for the same duty. The new motor runs at 1 000 r/min and draws 2,67 A under light conditions and runs at 935 r/min and draws 40,67 A under the required duty. The shunt winding resistance is 750 Ω and the armature resistance is 0,6 Ω.

4.1.1 Determine, neglecting armature reaction, the correct speed for the required duty.

4.1.2 Briefly discuss the reasons for this condition. (15)

4.2 State the advantages of used oil analysis for lubrication oil. (5)

QUESTION 5

5.1 The aluminium top of a high pressure hydraulic pump is held down with eight 6 mm x 30 mm, high tensile SI bolts (Young's modulus is 210 x 10^9). The thickness of the aluminium top and packing is 13 mm. A pretension of 500 kPa is induced in the bolts with a torque wrench, set very low to reduce the effect of friction in the threads and collar. Neglect the reduction in diameter due to the thread. The thread angle to the perpendicular is 30° and pitch is one millimetre.

How many turns must the bolt head be turned from the pretension position to raise the tension in a bolt to 350 MPa? (8)

5.2 As the appointed engineer you received the results of the six monthly rope tests. Sketch the resultant graph and indicate the important points on the graph and explain the importance of these points. (6)

5.3 From these results which characteristics forecast that a rope is approaching the end of its life? (6) [20]
QUESTION 6

6.1 The traversing speed of an electrically driven crab of an overhead crane is 0.375 m/s. The maximum lifting capacity is 5000 kg and the mass of crab is 2500 kg. The traversing drive has no mechanical brake and depends solely on electrical braking assisted by the resistance of the wheels on the track, which can be taken as 1350 N when the crab is fully loaded. The moment of inertia of the traversing motor armature is 0.04 kg m² and the speed of the motor is 950 r/min. The diameter of the wheels is 125 mm and the wheels are driven by double reduction gears with ratios of 18 to 110 and 15 to 82 and the efficiency of the gearing is 90%.

Calculate the maximum distance the crab will travel after a power failure whilst the crab travels fully loaded and the electrical brake fails as well. (12)

6.2 State and briefly describe the losses you anticipate to find in a large transformer. (4)

6.3 Briefly describe the protection devices on a large transformer. (4)

QUESTION 7

A slimes pump has an efficiency of 48% and must pump slime to a slimes dam against a static head of 25 m. The density of the dry solids is 2.4 t/m³ and the solid to water ratio is 1.1/1 by mass. The pump column is 750 m long and has a diameter of 150 mm. Make practical assumptions because the quantity pumped could not be measured due to the nature of slime.

7.1 Calculate the dry mass of the solids that can be pumped per day, if the motor is drawing 55 A from a 550 V, 3 phase supply. (15)

7.2 Discuss briefly the potential problems and develop procedures to start the pump after an unplanned power failure of six hours. (5)
QUESTION 8

8.1 A 600 mm wide, six-ply troughed-belt conveyor running at 2.0 m/s is required to deliver crushed stone at 230 t/hr over a horizontal distance of 150 m with a lift of 25 m. The belt is driven by the head pulley, 0.6 m diameter, and the tension is maintained with a gravity take-up after the head pulley. The angle of lap is 210° and the friction between the belt and pulley is 0.23. The tension for this belt is NOT to exceed eight kN/m width/ply and 11% of the shaft power is absorbed by friction.

8.1.1 Calculate the power required and the gearbox ratio to drive the belt if a four-pole motor is used.

8.1.2 Determine the mass of the gravity take-up.

8.1.3 Comment on devices preventing run-back. (3 × 4) (12)

8.2 In the Code of Practice on 'The safe use, operation and inspection of man-riding belt conveyors,' SABS 0266:1995, recall and enumerate the requirements with regard to the following:

8.2.1 Safety devices (2 × 4) (8)
8.2.2 Responsibilities [20]

QUESTION 9

9.1 An underground rescue chamber which is equivalent to an area of radius 5 m, is to be illuminated by a single lamp vertically above. The minimum illuminance is six lux and the maximum illuminance is 20 lux. Assume the luminous intensity to be uniform in ALL directions and that the utilisation factor is 0.6.

9.1.1 Find the mounting height in meters.
9.1.2 Find the mean spherical luminous intensity of the lamp. (2 × 5) (10)

9.2 Enumerate and describe the purpose of the required equipment for a rescue chamber. (5)

9.3 What is the designed area for a person in the rescue chamber? (5)

TOTAL SECTION B: 40
GRAND TOTAL: 100
PLANT ENGINEERING: MINES AND WORKS

INFORMATION SHEET

Cable Information for 4 core PVC cables.

<table>
<thead>
<tr>
<th>Voltage rating</th>
<th>1 000 V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm²</td>
</tr>
<tr>
<td>Conductor size</td>
<td></td>
</tr>
<tr>
<td>Current rating at 70 °C</td>
<td>Ω/km</td>
</tr>
<tr>
<td>Impedance at 70 °C</td>
<td></td>
</tr>
<tr>
<td>Conductor DC resistance</td>
<td></td>
</tr>
<tr>
<td>Reactance at 70 °C</td>
<td></td>
</tr>
</tbody>
</table>

Derating factors
In ground 1 000 V 0,95
In air 0,98
In water 1,00

\[ I_{illuminance} = \frac{\text{luminous intensity}}{h^2} \]

\[ T_1 = T_2 e^{\mu^2} \quad v^2 = u^2 + 2as \quad M = Fr \quad V = IR \quad F = \sigma A \quad \sigma = E \quad \varepsilon \quad \chi = \varepsilon l \]

\[ T = I \alpha \quad T = Fr \quad F = ma \]

\[ P = \sqrt{3} VI \cos \theta \quad \sigma_{friction} = \frac{0.002 H^2 \rho}{d} \quad \text{Power} = \frac{hQ \rho g}{n} \quad \text{Power} = \frac{mgh}{n} \quad \text{Power} = (T_1 - T_2) \nu \]