education

Department:
Education
REPUBLIC OF SOUTH AFRICA

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NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: MINES AND WORKS

(8190306)

13 November (X-Paper)
09:00 – 12:00

CLOSED-BOOK EXAMINATION

This question paper consists of 7 pages, an information sheet, a formula sheet and an answer sheet.

DEPARTMENT OF EDUCATION
REPUBLIC OF SOUTH AFRICA

NON-NATIONAL CERTIFICATE: ENGINEERING CERTIFICATE OF COMPETENCY
PLANT ENGINEERING: MINES AND WORKS
TIME: 3 HOURS
MARKS: 100

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. SECTION A is COMPULSORY.
2. Answer any TWO questions in SECTION B.
3. Read ALL the questions carefully.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Rule off across the page on completion of each question.
6. ALL calculations must be shown.
7. Use only black or blue ink.
8. NO cellular phones are allowed in the examination room.
9. Questions are based on the requirements and practical application of the Mine Health and Safety Act, 1996 (Act 29 of 1996) and the regulations framed under Schedule 4. Answers must be confined to these requirements.
10. Candidates arriving 30 minutes late will NOT be allowed to sit for the examination. NO candidates writing the examination may leave the examination room before ONE hour after commencement of the examination.
11. Candidates who have NOT been accepted by the Commission of Examiners will be disqualified.
12. This is a CLOSED-BOOK EXAMINATION. Candidates may NOT use any notes, text books or reference works during this examination.
13. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 You are to prepare a section of an MD 1 (DME 343) for a licence for a manual driven, DC, double-drum, man/material winder with two cages, operating in a vertical shaft.

Complete the section of the MD 1 (DME 343) on the ANSWER SHEET (attached) from the epitome below:

SHAFT

Depth, vertical from bank m	*1995*	To be tested for m Proposed ultimate m	*1920* *1927*

CONVEYANCES

No. of decks	*3*	Mass of conveyance kg	*5 210*
Type of doors	*Double leave; only opens to the inside*	Mass of bridle kg	
Floor space for persons	*39 m^2*	Mass of crosshead kg	
Description of cover	*2 mm corten steelplate supported by 100 mm corten lip channel, spaced at 800 mm intervals*	Mass of attachments kg	*1 590*
Type of conveyance	*Square conveyance with 100 mm corten lip channel frame covered with 1,5 mm corten steel plate*	Total mass kg	*6 800*
Number of persons allowed	*78*	Allowed material mass per cage kg	*5 500*

WINDING ROPES

Present condition of each rope (noting defects)	*new*	Is spare rope kept in reserve	*Yes*
Attachment at drum end	*Clamped with three crosby clamps to a drum spoke*	Is the rope record book in order	*Yes*
Number of coils on drum with conveyance at greatest depth	*15*	Is machinery record book in order	*Yes*
Maximum layers of rope on drum	*3*	Diameter of rope mm	*50,8*
		Mass of rope kg/m	*10,45*

(12)

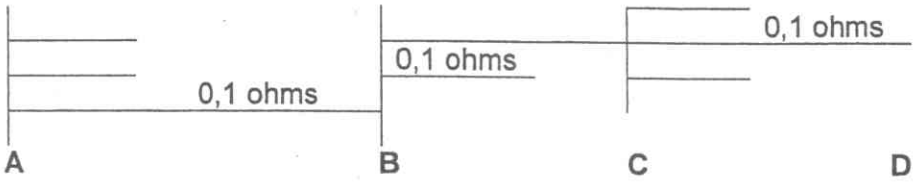
1.2 Under what circumstances is the brake lever of a double drum man winder locked in the 'on' position?

(8)
[20]

QUESTION 2

2.1 A distribution network as shown, is connected to a solid 6,6 kV supply at A and a zero impedance short circuit fault occurs at D. Impedance protection relays, driven by current and voltage transformers at every circuit breaker, are operating the circuit breaker at A, B and C. The impedance of the cable between the sections is 0,1 Ω.

Ensure that the impedance protection relays at A and B (sensitive to V/I) will not operate with a fault at D.



(10)

2.2 A three phase, 5 kVA, 550/120 V transformer supplies power to a string of haulage lights fitted with 60 W incandescent globes.
The string is made up from a four core, 4 mm^2 cable with a globe spacing of 30 m per phase. The three phases carry a globe every 10 m in turn, starting close to the transformer.
The voltage drop at the last globe is not to exceed 10% of the supply voltage.

Calculate the length of the lighting string which meets these requirements. (10)
[20]

QUESTION 3

Fully describe the initial and periodic inspections and load testing of a 20 t electrical overhead travelling gantry crane after construction. **[20]**

TOTAL SECTION A: 60

SECTION B

Answer any TWO questions from this section.

QUESTION 4

The production capacity of hauling ore in an underground haulage with trackbound or trackless equipment is to be calculated. You are tasked to present a recommendation on trackbound equipment according to the 'Guideline for the Compilation of a Mandatory Code of Practice for underground Railbound Transport Equipment' dated 1 February 2004.

INFORMATION

Gradient dipping towards the tips	0,5%
Mass of locomotive with batteries	5 t
Battery voltage	110 V
Mass of empty hopper	2,5 t
Mass of payload	5 t
Rolling resistance of the locomotive	70 N/t
Rolling resistance of a hopper	75 N/t
Coefficient of friction between track and wheels	0,19
Coefficient of friction between brake shoe and wheels	0,25
Brake shoes per locomotive wheel	2
Number of hoppers	3
Cycle time	3 h 30 min
Light beam distance	26 m

4.1 What is the maximum speed of a fully loaded train to the tips if the safety braking distance was found to be 25 m. The brakes were applied with a hand-wheel and a long screw.

4.2 What is the production rate for a 16 hour shift, with delays and maintenance of 1 h 30 min? Assume that the cycle time varies directly with the inverse of the speed ratio.

4.3 Recommend methods to increase the production rate according to the above-mentioned 'Guideline' without adding another shift or to increase the weight of the locomotive as the structure cannot accept more weight and still remain within the brake requirements.

4.4 Calculate the energy output in kWh/ton in both cases. Assume that acceleration is half the calculated deceleration. **[20]**

QUESTION 5

5.1 Describe the features and drawbacks of the electrical motor used in battery locomotives. Give current voltage relationships to support the description. Describe briefly the features of a controller for this motor. (10)

5.2 What are the main points to be observed in the selection and installation of a lightning arrestor in order to provide satisfactory protection for electrical equipment? (10)
[20]

QUESTION 6

6.1 Explain the meaning and purpose of the following terms as applied to a rail track:

6.1.1 Super-elevation
6.1.2 Compensated grade
6.1.3 Vertical curve
6.1.4 Transition curve
6.1.5 Ideal haulage for traction underground (15)

6.2 A drain in a mine haulage having a constant gradient of 0,75% is made from pre-cast concrete semi-circular forms with an internal radius of 250 mm.
Can this drain accommodate the peak flow of the mine wash water for 4 hours at a rate of 10 m^3/min? Allow a freeboard of 10 mm for sludge in the drain, and assume a coefficient of C = 60. (5)
[20]

QUESTION 7

7.1 Describe the mechanical and functional difference between a fluid coupling and a hydraulic torque converter. (10)

7.2 Determine the dimensions of a short hollow shaft which has to transmit 75 kW at 300 r/min, if the maximum shear stress in the shaft is limited to 70 MPa and the ratio of the diameters is 3 to 4. (10)
[20]

QUESTION 8

8.1 A straight conveyor belt, inclined at 15° to the horizontal, is 120 m long between the loading and discharge points and runs at 1,25 m/s. The mass of a 0,5 m long sample removed from the belt is 38 kg. The total friction can be taken as 9 kN concentrated at the centre of the belt.
If the angle of wrap is 240° and the coefficient of friction between the driving head-pulley and belt is 0,3.
Determine the following:

8.1.1 The mass of a weighted tension carriage assembly necessary to prevent the belt slipping

8.1.2 The motor power output (11)

8.2 An ammonia compression refrigerating machine has to produce 40 t of ice per 24 hours, from and at 0° C. The temperature limits are 27 °C and -21°C.

Determine the following:

8.2.1 The refrigerating capacity in kW

8.2.2 The coefficient of performance under ideal conditions

8.2.3 The required power of the driving motor assuming an efficiency of 70% compared with ideal conditions (9)

[20]

QUESTION 9

9.1 Discuss the fundamentals of corrosion and the roles of anodes and cathodes in the corrosion process (10)

9.2 A journal of diameter 150 mm runs in a bearing 300 mm long. The lubricant used has a density of 855 kg/m^3 and a kinematic viscosity of $1,8 \times 10^{-4}$ m^2/s. If the radial clearance is assumed to be uniform and equal to 0,05 mm, determine the power required to overcome the viscous resistance of the lubricant when the journal rotates at 5 r/s. (10)

[20]

TOTAL SECTION B: 40
GRAND TOTAL: 100

ANSWER SHEET **EXAMINATION NUMBER:**

QUESTION 1

Part of MD 1 (DME 343) to be completed and placed inside the ANSWER BOOK.

A. Capacity factors

Distance from sheave to lowest winding point *1980* m

Corresponding mass load of rope kg

Breaking force of rope (a) 1785 kN (b) *1720* kN

Capacity factors below based on rope breaking load of ..... kN

Type of conveyance	Weight of conveyance kN	Weight of persons kN	Weight of material kN	Weight of mineral kN	Weight of explosives kN	Effective combined weight kN	Capacity factor

B. Static factors

Description of attached load	Attached load effective combined weight kN	Rope effective length weight kN	Suspended load weight kN	Static factor

INFORMATION SHEET

Cable Information for 4 core PVC cables

Voltage rating			1000 V						
					3,3 to 11 kV				
Conductor size	mm^2	4	6	10	16	95	120	150	185
Current rating at 70 °C	A	48	59	79	100	235	280	310	350
Impedance at 70 °C	Ω/km	10,5	9,76	8,93	8,32	4,33	3,78	3,33	2,87
Conductor DC resistance	Ω/km	4,48	2,99	1,79	1,12	0,19	0,15	0,12	0,10
Reactance at 70 °C	Ω/km	9,50	9,29	8,75	8,24	4,33	3,78	3,33	2,87
Short circuit rating	kA/1 s	0,6	1,1	1,8	2,2	13,3	16,8	20,7	25,9

De-rating factors

In ground 1000 V	**0,95**
In air	**0,98**
In water	**1,00**

$$Illu\min ance = \frac{lu\min ous\ int ensity}{h^2} \qquad Verligting = \frac{ligverspreiding}{h^2}$$

$T_1 = T_2 e^{\mu\theta}$	$v^2 = u^2 + 2as$	$M = Fxr$	$V = IxR$	$F = \sigma xA$	$\sigma = Ex\varepsilon$	$x = \varepsilon xl$

PLANT ENGINEERING: MINES AND WORKS

FORMULA SHEET

$P_c = \frac{4\pi^2 EI}{l^2}$ $P_c = \frac{\pi^2 EI}{4l^2}$ $P_c = \frac{\pi^2 EI}{l^2}$ $P_c = \frac{2{,}05\pi^2 EI}{l^2}$	$T_f = 2T_m \frac{s\alpha}{\alpha^2 - s^2}$ $\tau = \frac{16T}{\pi d^3}$ $M_b = \frac{Wl}{8}$ $\frac{T}{J} = \frac{\tau}{r} = \frac{G\theta}{l}$ $\tau^2 = M_b^2 + T^2$ $M_b = \frac{wl^2}{8}$	$I_{sh} = I x \frac{100}{\%X}$ $\%X = \frac{IX}{E} 100$ $Z_{base} = \frac{V_{base}}{I_{base}}$ $I_{base} = \frac{kVA_{base}}{\sqrt{3}\, kV_{base}}$
$\Delta p = \rho c (V_2 - V_1)$ $c = \sqrt{\frac{bulk\ modulus\ of\ water}{density\ of\ water}}$ $T_r^2 = w^2 x^2 \left[\left(\frac{x^2}{4y^2} \right) + 1 \right]$	$I = \frac{\pi d^4}{64}$ $I = \frac{\pi d^4}{32}$ $I = \frac{\pi (D-d)^4}{64}$ $I = \frac{\pi (D^4 - d^4)}{64}$ $I = \frac{\pi (D-d)^4}{32}$ $T_c = \frac{1}{3} T_1$	$Gd^4 = \frac{8PD^3 n}{y}$ $Gd^3 = \frac{8PD^4}{y}$ $Tan\,\phi = \frac{2y}{x}$ $T_0 = \frac{wx^2}{2y}$
$Q = \frac{Aa}{\sqrt{A^2 - a^2}} C_d \sqrt{2g} \sqrt{h}$ $\frac{T_1}{T_2} = e^{\mu\theta cosec\beta}$ $(T_1 - T_2)(T_2 - T_c) = e^{\mu\theta cosec\beta}$	$W = \frac{n}{n-1} x\, mRT\, x \left(r_p^{\frac{n-1}{n}} - 1 \right)$ $T_2 = T_1 \left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}}$ $W = mC_p (T_2 - T_1)$	$h_f = \frac{4flv^2}{2gd}$

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