EXAMINATION FOR THE ENGINEERS' CERTIFICATE OF COMPETENCY

PLANT ENGINEERING MINING

1 June 'X-Paper' 10h00-13h00

REQUIREMENTS: Graph paper.
Pocket calculators may be used.

EXAMINER:
Commission of Examiners

MODERATOR:
Mr C.L. van der Spuy

Total marks: 300
To pass: 100

Candidates are allowed to use any notes, text or reference books in the examination.

Calculators may be used but all calculations are to be shown.

Candidates are expected to make reasonable assumptions where necessary and these together with any formula used must be clearly stated. No credit will be given for calculations in which the steps cannot be clearly followed.

Answer the FIRST TWO questions and ANY THREE other questions.

1. (a) Mention all the important items to be checked on a double-drum winding plant intended to convey persons in a deep vertical shaft before the final commissioning inspection. (15)

(b) Describe briefly two methods which will ensure equal rope tension on a Blair multi-rope winder. (5)

(c) Discuss the advantages and disadvantages of a multi-rope winder compared with a conventional double-drum winder for a deep vertical shaft. (5)

(d) Calculate the diameter of the ropes for a 4-rope Blair winder for a vertical shaft 2 000 m deep. The maximum attached load is 28,6 t. (15)

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P.T.O.
1. (a) Calculate the 3 resistances of a 6-step rotor starter for a 3-phase induction motor from the following data:

Maximum starting current = full load current

Full load speed = 980 r/min

Rotor resistance per phase = 0.015 ohm

(b) The iron losses of a 500 kVA transformer are 4 kW and the full load copper losses are 2 kW. The transformer is energised for 3 hours per day and the maximum demand is 500 kW. The load factor is 45%. The tariff is R15 per kW of maximum demand per month and 2 cents per kwh.

Calculate the present value of the losses if the life of the transformer is 20 years and the interest rate is 14% per annum.

(c) Draw the circle diagram for the transformer mentioned in (b).

3. (a) (i) Sketch the characteristic pressure-volume curves for fans with forward-curved blades and fans with backward-curved blades.

(ii) State the applications of the two types of fans.

(iii) Use your sketch for the fan with forward curved blades to derive the characteristic curve for 2 such identical fans operating in parallel.

Indicate on your sketch the capacity at which the operation will be stable.

(b) (i) Discuss the causes of a low, lagging power factor in the electrical supply to a colliery.

(ii) Suggest methods which can be adopted to improve the power factor of such a colliery.

(iii) What are the advantages of providing power factor correction to a colliery electrical plant?
(iv) In relation to power factor correction explain why the degree of correction may need adjustment from time to time and explain briefly how this can be done for each of the methods you suggested in (ii).

4. (a) (i) What are the main causes of "hang-ups" or bridging in smooth walled ore passes which have an inclination of 60° or more to the horizontal.

(ii) Describe briefly two methods by which the potential energy of the contents of an ore pass which has "hung up" can be safely dissipated when the contents become dislodged and fall.

(b) Draw a simple hydraulic circuit diagram for a spring applied, hydraulically released brake system for a 200 kW single drum winder for an inclined shaft. The control must be infinitely variable and may be controlled directly or remotely by pilot pressure or electricity. Show how fast and slow emergency braking is obtained.

5. (a) Compare the advantages and disadvantages of metallic grid and liquid rotor resistances used for the speed control of a large underground a.c. winder motor.

(b) An overhead transmission line has a span of 250 m between supports on the same level. Each conductor has a cross-sectional area of 110 mm², a mass of 1.02 kg/m and a breaking stress of 400 MPa.

Calculate the sag for a factor of safety of 5, allowing for a wind pressure of 500 N/m² of projected surface area.

(c) The copper conductor of an overhead transmission line carries a maximum current of 240 A with voltage drop as the limiting factor. Calculate the relative mass per unit length of a suitable aluminium conductor to perform the same function.
6. (a) A chairlift installation must convey 450 persons per hour up a 34° incline through a vertical height of 136 m by means of chairs suspended from chain driven carriers running on a rail circuit. Both landings are level and 12 m long. The velocity of the traction chain is 1.3 m/s and its mass is 7.38 kg/m. The mass of the safety rope is 1.5 kg/m. The mass of each carrier is 5 kg while that of a chair is 12 kg.

Assume an appropriate friction factor and calculate the total pull in the chain:

(i) at the driving sheave, and

(ii) at the bottom sheave when the upgoing chairs are loaded.

(iii) Assume that the driving sheave is designed to suit the minimum permissible distance between the rails and calculate the minimum diameter of the drive shaft required for the sheave. (25)

(b) Briefly describe a safety device to protect a large, unattended, multi-stage centrifugal pump from running dry.

Explain why such a device is necessary and how it permits initial starting. (10)

(c) After its capacity had dropped significantly an old single stage, double suction centrifugal pump was reconditioned to restore the clearances to the original values. After return to service the delivery was found to be less than before the repair and power consumption had increased. Discuss possible causes. (5)

7. (a) Describe the types of lubricant you would specify for each of the following applications. Give reasons for your choice.

- Worm reduction gears
- Hot-air fan bearings
- High speed spur gears
- Four-stroke diesel engine
- Rock drills
- Ammonia refrigeration plant
- Hydraulic braking system (30)
8. As a subordinate engineer responsible for a shaft section of a new mine you have to establish a supervisory structure and staff complements for the engineering section. Your section includes the following:

3 large surface winders, the vertical shaft, trucks and tramways, a surface cooling plant, 30 underground scraper winches, 5 small underground hoists, 15 monorope installations, a headgear elevator, a subincline shaft and its winder.

Show the type of management diagrammatically with subdivisions of sections. Indicate the number and level of supervisors required as well as artisans, drivers, labourers etc.