

Nov '00



C471(E) (N23)G
NOVEMBER 2000

DEPARTMENT
OF
EDUCATION

EXAMINATION FOR THE ENGINEER'S
CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: MINES AND
WORKS
(8190306)

EXAMINER:
Commission of Examiners
MODERATOR:
Commission of Examiners

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

Programmable calculators must
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. Full marks: 100
Pass mark: 50
2. Answer QUESTIONS 1, 2 and 3 and any TWO other questions.
3. No credit will be given for calculations in which the steps cannot be followed or for work completed in pencil.
4. Answers must be clear, correctly numbered, neat and legible.
5. Candidates who were not, prior to the examination, accepted by the Commission for Examiners (Department of Minerals and Energy), will be disqualified.

PTO

QUESTION 1 (COMPULSORY)

- (a) During the monthly rope inspection of a winding rope for a man winder, it was found, by using a magnetic rope test instrument, that three outer wires had broken in one strand within one lay length of an ultra high tensile triangular strand steel rope. The nominal rope diameter is 42 mm, the construction 6 x 30 Δ /F and the tensile grade of the steel is 1 900 MPa. The rope has an actual breaking force of 1 390 kN. The fractures are near the conveyance end of the rope.

Determine the percentage loss of area and describe the steps that you, as the responsible engineer, will take to assess the impact of the broken wires on the use of the rope and the criteria you will take into account to decide whether to continue using the rope or to discard such a rope.

The factor of safety is 6 and the capacity factor 10,1. There is no reduction in the diameter of the rope nor any corrosion. The following additional information is given on the rope certificate:

Construction of rope	Comp tri strand	
Lay, type and length	RHL, 316	
Number of strands	6	
Number of wires in strand	30 (12/12/6 + 3T)	
Diameters	3,05, 1,84, 1,56, 1,16.	
Class of heart of rope	Fibre	
Class of strand core	Plaited	(10)

- (b) The capacity of a Koepe rock winder has to be increased by 10% by increasing the full speed and the acceleration rate and deceleration of the skips. The utilisation factor over a 22 hour period is 0,95. The acceleration and deceleration rate, is uniform and equal to $1,1 \text{ m/s}^2$. The loading time is 20 seconds, the length of the wind from loading box to tip is 1 880 m and the maximum speed of the conveyance is 13,5 m/s.

Calculate the increased speed, acceleration and deceleration rate for the increased capacity. The acceleration and deceleration period remain unchanged.

(10)
[20]

QUESTION 2 (COMPULSORY)

- (a) A three-phase, four wire 380 V underground electrical distribution system consists of a three-phase load of 100 kW at a power factor of 0,8 and three single-phase loads of 30, 40 and 50 kW respectively. Determine the current in each of the FOUR conductors.

(10)

- (k) The delivery of a sludge pump must be varied by changing the slip-ring motor speed to 50% of the speed when the slip rings are short circuited with a 4% slip.

Calculate the additional star connected resistance to be connected to the slip rings to achieve the decrease in speed.

The three-phase 8-pole slip-ring motor is rated at 750 kW. The star-connected rotor winding has a resistance of

0,1 Ω /phase and a standstill leakage reactance of

0,5 Ω /phase. The frequency is 50 Hz.

(10)

[20]

QUESTION 3 (COMPULSORY)

- (a) You are in charge of the mine workshop which, amongst other work, also services earthmoving machinery. Identification marks have to be burned onto the external sidewalls of large earthmoving tyres. Two types of branding irons are used, that is electrically heated and gas heated irons. The branding process gives off unpleasant fumes and thus the branding is done in the open air. The person doing the branding has been employed in the workshop in that capacity for eight years since he/she started working there. He/she recently developed a breathing problem which affects his/her stamina and ability to manhandle the tyres.

Describe in detail:

- (i) How you will investigate the hazards attached to the tyre branding task
- (ii) What resources you will make use of in your investigation
- (iii) What recommendations you will make to minimise or eliminate the hazards identified

(15)

- (b) Make a neat sketch of an effective guard for the tail pulley of a conveyer belt. Give critical dimensions in terms of the pulley diameter.

(5)

[20]

Answer any TWO of the following questions.

QUESTION 4

- (a) Steam from a boiler is supplied to an autoclave for curing rubber. A combined separating and throttling calorimeter was newly installed in the supply line to control the dryness fraction of the steam. You conducted the first test and recorded the following results:

Steam pressure	700 kPa (abs)
Water in separating calorimeter	0,34 kg/min
Pressure after throttling	101 kPa (abs)
Temperature after throttling	99,87°C
Water condensed from throttling calorimeter	7,9 kg/min

Discuss the quality of the steam and the validity of the test.

From steam tables:

p(kPa)	t _s (°C)	h _f (kJ/kg)	h _{fg} (kJ/kg)	h _g (kJ/kg)	
100	99,6	418	2258	2676	
110	102,3	418	2258	2676	
700	165	697	2065	2762	(10)

- (b) A used, normally aspirated diesel engine generating set was installed on a sinking shaft to provide an alternate electrical supply to the kibble winder. The rated power of the set is only marginally in excess of the required power to drive the winder.

(1) Describe how you will set up a temporary resistance to measure the power of the generating set in order to assure that it will be capable of providing sufficient power to the winder in an emergency. The winder has not yet been commissioned. The set is rated at 350 kW by the manufacturer and provides three-phase power at 400 V.

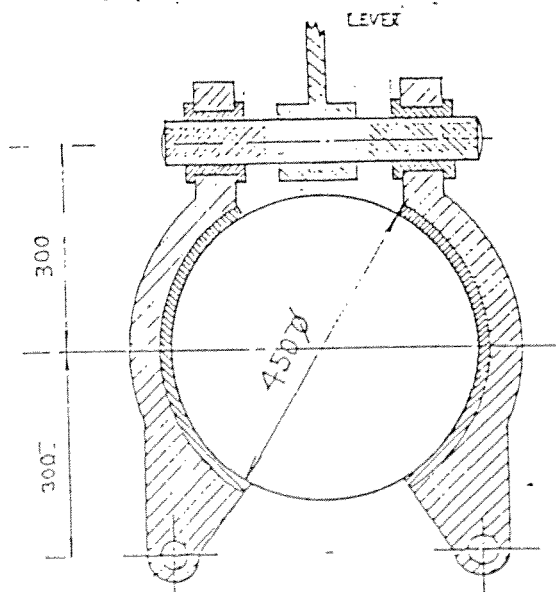
(2) The test revealed that the diesel engine is incapable of the required power. It overheated and the exhaust emitted thick black smoke under load. Describe the FOUR most important reasons for the poor performance.

(10)
[20]

QUESTION 5

- (a) Calculate the load that can be safely suspended from the hanging wall in an underground workshop by three standard 13 mm pig-tail eye bolts, 300 mm apart in a triangle and tied together. For the purpose of your calculation assume that the eye bolts will share the load equally and that the suspended load will be static. State clearly what ultimate stress and factor of safety you will use. (5)

- (b) The arrangement of a thruster-type emergency brake for a winder is shown diagrammatically in the following sketch. The drum diameter is 450 mm and the shoe pivot is directly below the shoe contact point on the drum. The shoes are pivoted and are forced onto the drum by rotating the shaft. The ends of the shaft are screwed right and left handed and work in nuts in the ends of the shoes. The lever that rotates the shaft is 200 mm long and connected to a spring applied, hydraulically released arrangement. The mean diameter of the screwed ends of the shaft is 20 mm and there are six start square threads with a lead of 22 mm. The coefficient of friction for the brake blocks is 0,3 and for the screws and nut is 0,15. Find the spring force to be applied at the end of the lever for a braking torque of 360 Nm.



(15)
[20]

QUESTION 6

(a) A new single stage centrifugal pump was installed about two years ago to pump raw river water to the plant at 1,2 kl/min and a head of 70 m. The pump capacity faded and during inspection you found the pump casing has been worn beyond repair and your expectation. The pump has a cast iron casing, bronze impeller and rings. Describe how you will determine whether the condition is due to:

- Erosion
- Corrosion
- Galvanic action
- Cavitation
- Poor design

Describe the steps you will take, in each of the above-mentioned cases, to extend the life of a similar replacement pump.

(10)

(b) A belt-driven fan has been imported as part of an installation, but is not performing as it should. On investigation, you find that the motor driving the fan was designed for a 60 Hz supply, sea level operation and an ambient temperature of 15°C. The plant is at 1 525 m altitude with a mean ambient temperature of 32°C. Air density at 32°C is 0,944 times that of air at 15°C constant altitude. Atmospheric pressure at sea level is 101,3 kPa and at 1 525 m it is 84,3 kPa at constant temperature.

What must be done to increase the fan delivery pressure to specification and what is the new power requirement?

(10)
[20]

QUESTION 7

(a) The brushes of a commutator type motor for an underground locomotive, has a very short life and must be replaced very frequently. List the possible reasons and steps you will take to correct each condition.

(8)

(b) The earth fault current of an 11 kV three-phase circuit was found to be excessively large when solid grounding is used. The circuit consists of an overhead line having line to ground capacitance of which each line is equal to 0,015 μ F. Calculate the value of the reactance to be connected in the neutral connection to neutralise the capacitive current. The frequency is 50 Hz.

(8)

- (c) Make a neat diagrammatic sketch of the pilot wire system for a trailing cable used in a mine in a hazardous area.

(4)
[20]

QUESTION 8

- (a) It was reported to you that miners' caplamp assemblies are being used illegally to set off explosives and due to damage to the assembly has caused short circuits that have the potential to start an underground fire. Detail the steps you will take to terminate this practice. Consider the implications of each of your actions.

(5)

- (b) Sketch and describe an explosion-protected caplamp to be used underground in a hazardous area.

(5)

- (c) A load haul dumper is used underground in a mine and operates at places where it can run out of control and thereby endanger the safety of persons. The load haul dumper is equipped with a disc brake on each wheel. Calculate the axial force to be applied to a two-disc multi-plate spring applied type brake. The outer and inner diameters of the friction surfaces are 280 and 220 mm respectively. The coefficient of friction is 0,07 and a braking torque of 80 Nm per wheel is required. Assume uniform intensity of pressure for calculating the friction radius.

$$r = (2/3) \cdot (r_1^3 - r_2^3) / (r_1^2 - r_2^2)$$

(10)
[20]

TOTAL: 100
