T40(E)(J10)T
JUNE 2002

DEPARTMENT OF EDUCATION

ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: MINES AND WORKS

(8190306)

EXAMINER:
Commission of Examiners
MODERATOR:
Commission of Moderators

10 June (X-Paper)
09:00 – 12:00

Alphanumerical or programmable calculators may NOT be used.

Only non-programmable calculators may be used.

CLOSED-BOOK EXAMINATION

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

INSTRUCTIONS

1. Answer QUESTIONS 1, 2 and 3 in SECTION A and any TWO of the five questions in SECTION B.
2. ALL the calculations are to be shown.
3. NO credit will be given for calculations in which the steps cannot be clearly followed or for work completed in pencil.
4. Candidates are expected to make reasonable assumptions where necessary and these, together with any formulae used, must be clearly stated.
5. Rule off on completion of each answer.
6. Answers must be clearly and correctly numbered. Write neatly and legibly.
7. Illegible answers will not be marked.

Uniform acceleration away from the tip	2 m/s^2
Uniform deceleration to the tip	2 m/s^2
Loading time = tipping time	10 s
Total inertia of rotating parts refer to the drum shaft	11 000 kg m^2
Rolling resistance of the skip	150 N/t
Rolling resistance of the rope	9 N/t/m
Total length of rope	700 m
Mass of rope	2,775 kg/m
Coefficient of friction between brake shoe and brake path	0,3
Degree of protection (DOP)(minimum)	1,4

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

Calculate the maximum force, F, that must be applied to the end of the brake lever to stop a downgoing empty skip within the minimum distance as required by Directive C2 when the speed controller fails at the commencement of the deceleration phase. Assume that the available stopping distance commences with the application of the brakes. [20]

QUESTION 2

An imported induction motor with unique insulation, drives a compresser which is essential to the production line. The compressor is subjected to varying demands. It is thus important to avoid or minimise damage to the motor, which has the following particulars:

4 MW, 6,6 kV, 3 phase, 1 480 r/min with forced ventilation.
Squirrel cage, star connected, both ends of each phase winding accessible. Locked-rotor stall withstand time 10 s.
Starting direct on line. Normal run up time is 20 s.
Outboard white metal pedestal bearings with oil rings.

2.1 State all the protective devices you would specify for the motor and its switchgear, briefly describing the purpose and function of the devices. (14)

2.2 Illustrate by means of sketches and describe the principle of operation of TWO methods of applying earth-leakage protection to a three-phase cable feeder which would discriminate successfully among earth faults. (6)

[20]

QUESTION 5

5.1 Briefly describe considerations that should be taken into account before installing a booster fan in a coal mine. (5)

5.2 One longwall district of a mine consists of an intake airway 2 km long, a face and 2 km return airway. The face has a resistance of 2 Ns^2/m^8 and the intake and return airways have resistances of 0,1 $Ns^2/m^8/km$ and 0,15 $Ns^2/m^8/km$ respectively. The midpoints of the intake and return airways are to be connected by a pump chamber having a resistance of 10 Ns^2/m^8. A booster fan is to be installed in the return airway between the face and the pump chamber junction to ensure that the airflow through the chamber and the face is to be 5 m^3/s and 15 m^3/s respectively.

Ignore any other leakage effects and calculate:

(i) The differential pressure required between the inlet and outlet of the district

(ii) The pressure across the booster fan (15)

[20]

QUESTION 6

6.1 A cage with a mass of 16 tons is suspended by a 45 mm diameter rope with a mass of 8,701 kg/m. The cage got stuck in the shaft while it was being lowered and 2 m of slack rope was paid out before the drum was stopped. Fortunately the rope didn't kink at the attachment to the cage. The total length of rope between the cage and the sheave wheel at this point was 180 m. Before the slack rope could be taken up, the cage became dislodged and fell.
Calculate the maximum stress induced in the rope if the relative density of the steel for the rope is 7,84 t/m^3 and the elasticity modulus is 210 GPa. (14)

6.2 Sketch and describe the operations of a reverse pulse filter to filter 20 m^3/s of air from a stone crushing plant. (6)

[20]

QUESTION 7

7.1 A 3-phase, Y-delta, 50 Hz transformer supplying a winder has a secondary winding resistance of 0,1 ohm per phase and a reactance of 2 ohms per phase. The shape of the EMF wave is such that it contains prominent third and ninth harmonics with values of 6% and 3% respectively of the fundamental. What current would circulate in the delta winding of the transformer if the fundamental wave is 6 600 V_{rms}.? (12)

7.2 What are the responsibilities of the employer regarding the installation, operation and maintenance of explosion protective equipment used on an electrical driven coal cutter? (8)

[20]

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FORMULAE AND CONSTANTS

$$I = \frac{\pi}{64}\left(D^4 - d^4\right) \quad m^4$$

$$Q = \frac{Aa}{\sqrt{A^2 - a^2}} C_d \sqrt{2gh} \quad m^3/s$$

$$\frac{\sigma}{y} = \frac{M}{I} = \frac{E}{R}$$

$$p = (M + lm)\frac{g}{A} + M\left[1 + \sqrt{1 + 2\frac{hAE}{Ml}}\right] Pa$$

$$\Delta d = \frac{6l^3F}{bh^3NE} \quad m$$

Vapour pressure at 26 °C = 3,4 kPa

Vapour pressure at 95,2°C = 85 kPa

Density of water is 1 t/m³

Density of mercury is 13,6 t/m³

$$p = Q^2R\ Pa.$$

$$A = 0{,}465\ D^2\ m^2$$

$$h_f = 4\frac{flv^2}{2gd} \quad m$$

$$\Delta d = \frac{8ND^3{}_mF}{d^4G} \quad m$$