T2190(E)(N22)T
NOVEMBER 2001

DEPARTMENT OF EDUCATION

ENGINEERING CERTIFICATE OF COMPETENCY

PLANT ENGINEERING: MINING
(8190306)

EXAMINER:
Commission of Examiners
MODERATOR:
Commission of Examiners

22 November (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 be marked. All work you do not want to be marked, must be clearly crossed out.

INSTRUCTIONS

1. Answer QUESTIONS 1, 2 and 3 and any TWO other questions.
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 before starting a new question.
6. Answers must be clearly and correctly numbered. Write neatly and legibly.
7. Illegible answers will not be marked.
8. This is NOT an open-book examination. Candidates are NOT allowed to use any notes, textbooks or reference works during the examination.
9. Candidates who were not accepted by the Commission, will be disqualified.

PTO

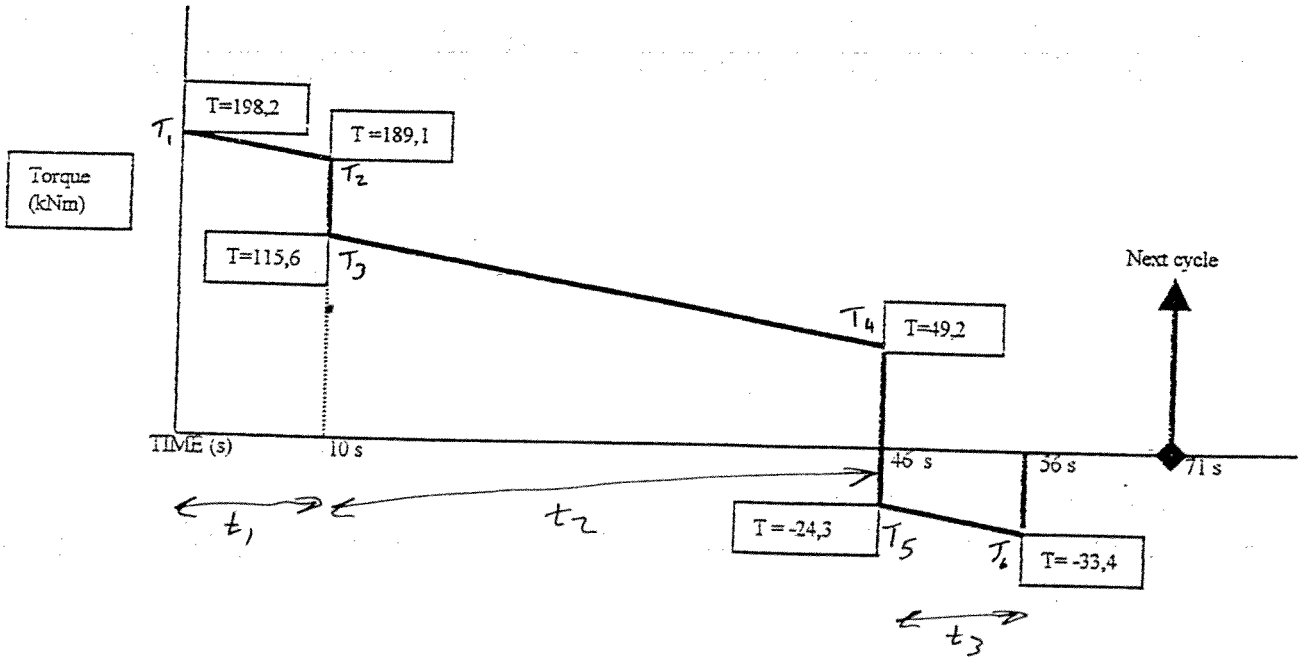
10. Candidates arriving 30 minutes late may not sit for the examination. No candidate writing the examination may leave the examination room before one hour after commencement.

QUESTION 1 (COMPULSORY)

(a) Calculate the capacity per hour of a double-drum mine-winder operating in a vertical shaft.

Constant acceleration period = constant deceleration period = 12 s
Constant acceleration = constant deceleration = 1,3 m/s^2
Loading time = 10 s
Length of wind = 1 540 m
Constant speed = 17,5 m/s
Capacity of skip = 4,5 t (3)

(b) The duty cycle diagram of a double-drum winder is shown. Calculate the r.m.s torque and the motor power. The maximum rope speed is 7,6 m/s, the efficiency is 95% and the winding drum diameter is 3,8 m.



R.m.s. torque = $\sqrt{\{[\Sigma(1/3)(T_1^2 + T_1T_2 + T_2^2)]/[(2/3)(t_a + t_r) + t_c + (1/3)t_d]\}}$ (17)
[20]

PTO

QUESTION 2 (COMPULSORY)

(a) What are the effects of switching resistances connected across the contact gaps of a 66 kV circuit breaker which operates frequently? (5)

(b) An electric motor is used to drive a harmonic vibrating screen. Due to extensive repairs, the mass of the screen was changed and thus the natural frequency changed. The shaft drive speed of the rotating mass has to be decreased from the present 970 r/min (revolutions per minute) to 910 r/min. The vibrating shaft is directly connected to the motor. The power input to the 415 V, three-phase, six-pole, 50 Hz induction motor is 50 kW when running at 970 r/min. The stator losses are 2 kW and the friction and windage losses are 1,5 kW.

Calculate:

(i) The rotor I^2R loss

(ii) The gross torgue in Nm

(iii) The power output of the motor

(iv) The rotor resistance per phase if the rotor phase current is 110 A

(v) The resistance to be added to each phase to achieve the reduced speed if the motor torque remains constant (15)

[20]

QUESTION 3 (COMPULSORY)

(a) Answer the following questions with reference to an oxy-acetylene system fitted with a cutting torch:

1. Sketch an acetylene gas regulator (diagrammatically).

2. State the fault circumstances for oxygen to enter an acetylene cylinder.

3. Why do flashbacks occur?

4. Where must the TWO flashback arrestors be situated? (10)

(b) At least once a month a person has to climb from ground level to the top of a 30 m high stack to do maintenance. Rungs are welded to the side of the stack for access.

Explain, with the aid of sketches, how you would provide for this person's safety. (5)

(c) Sketch a dust-extraction system of a crusher which emits health-threatening dust during operation. (5)
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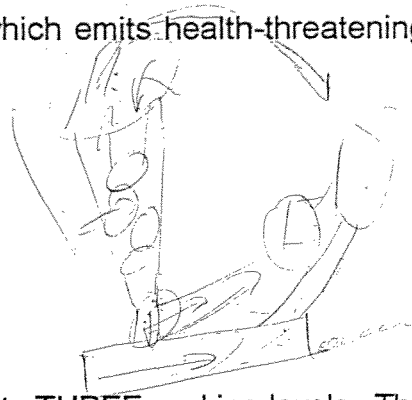

Answer any TWO of the following questions.

QUESTION 4

(a) Sketch a water-supply system down a deep shaft to THREE working levels. The working levels are 30 m vertically from one another and the water pressure at each level must at least be 40 m head. (5)

(b) 240 t/h of residue from a gold mine reduction plant must be pumped through a pipe for a horizontal distance of 1,5 km, round a 90° bend, for a vertical distance of 60 m, round a 90° bend and finally a horizontal distance of 100 m. The density of the mixture of residue and water is 1,35 t/m^3. The density of the dry residue is 2,7 t/m^3, the flow velocity in the pipe is 1,45 m/s and the pump efficiency 60%. Assume that the pipe is flowing full and that the mixture behaves as a dense liquid such that D'Arcy's formula ($h_{friction} = 4flv^2/2gd$) may be used.

Take the equivalent length of a bend as 6 x d where d is the diameter of the pipe. Calculate the diameter of the pipe and the power of the driving motor. (15)
[20]

QUESTION 5

(a) A refrigeration plant used underground in a mine has two evaporators in parallel located in separate ventilation districts. The refrigerant leaves the compressor at 651,6 kPa and the condensate is not undercooled. After throttling to 182,6 kPa, the refrigerant is passed to the first evaporator and leaves dry and saturated. The refrigeration effect of the first evaporator is 78,4 kJ/s. The remainder of the refrigerant is throttled to 261 kPa and passes to the other evaporator in which the refrigeration effect is 39,2 kJ/s. The refrigerant leaving the second evaporator is dry and saturated. It is further throttled to 182,6 kPa before mixing with the vapour from the first evaporator and then passing to the compressor.

Determine the refrigerant circulation (mass flow) in each evaporator and the coefficient of performance of the plant.

The enthalpy of the refrigerant:

At entrance to condensor at	651,6 kPa	206 kJ/kg
After condensor at	651,6 kPa	59,7 kJ/kg
After first evaporator at	182,6 kPa	180,97 kJ/kg
After second evaporator at	261 kPa	85,38 kJ/kg

(10)

(b) Steam for an autoclave is taken from the main at a pressure of 2 MPa and reduced to a pressure of 200 kPa. Determine the condition of the steam after the reducing valve if the steam in the main is 140°C overheated.

The specific heat of superheated steam is 2,09.

From steam tables:

p kPa	t_s °C	h_f kJ/kg	h_{fg} kJ/kg	h_g kJ/kg
200	120,2	505	2 202	2 707
2 000	212,4	908	1 889	2 797

(10)
[20]

QUESTION 6

(a) Sketch and describe the operation of an unloading valve in a hydraulic circuit for a single cylinder under load on the out stroke and no-load during the in-stroke. (5)

(b) Sketch the hydraulic circuit for a spring-applied hydraulic-release brake for a mine winder. Draw only the circuit for ONE cylinder. (5)

(c) Draw the profile of a rotating cam to retard a winder at the end of the wind. The cam has a base circle diameter of 250 mm and must impart uniform velocity motion to a roller-ended follower during 90° cam rotation. The roller diameter is 30 mm and the stroke is 50 mm. The follower remains at the outward extremity for 30° of cam rotation when the cam reverses its direction. (10)
[20]

QUESTION 7

(a) Sketch and describe THREE important protection devices for large transformers. (5)

(b) As a temporary measure, two 250 kVA transformers have to be connected in parallel to supply an underground network of a mine. The voltage ratios are the same, their resistance drops are 1,5% and 0,9% respectively and their reactance drops are 3,33% and 4,0% respectively. Calculate the kVA loading of each transformer to ensure that none would be overloaded in excess of 10%. The network load is 500 kVA with a power factor of 0,707.

Phasor expression:

$$P_{\text{Total kVA load}} = P_{\text{kVA load per transformer}} \times Z_{\text{percentage impedance per transformer}} / (Z_1 + Z_2)$$ (15)
[20]

QUESTION 8

(a) A V-belt drive consists of two V-belts in parallel on grooved pulleys of the same size. The groove angle is 30°. The cross-sectional area of each belt is 750 mm^2 and the coefficient of friction is 0,02. The density of the belt material is 1,2 t/m^3 and the maximum safe tension is 5, 25 kN.

(i) Calculate the power that can be transmitted between pulleys 300 mm in diameter rotating at 1 500 r/min.

(ii) Calculate the shaft speed at which maximum power is transmitted.

$$T_1/T_2 = e^{\mu\theta\text{cosec }\beta};\ (T_1 - T_C)\ (T_2 - T_C) = e^{\mu\theta\text{cosec }\beta};\ Tc = 1/3\ T_1$$ (5)

(b) A vibrating screen is modified and will now be suspended from four closely coiled extension springs. The total loaded mass of the screen is 3,54 t. Calculate suitable dimensions for the manufacturing of such springs. The ratio D/d is 5,88, the maximum torsional stress 450 MPa and the modulus of rigidity 80 GPa. The extension under load must not exceed 155 mm. There is no initial tension in the wire.

Calculate:

(i) The diameter of the wire
(ii) The mean coil diameter
(iii) The number of coils

$$\tau_{max} = 8FD^3n/Gd^4 \text{ and } \Delta = 8FD^3n/Gd^4$$ (15)
[20]

TOTAL: 100

fluorinated Hydro Carbon

082 8866 235 Jan Botes

fluorine - pungent corrosive gas
Sharp taste or smell

Hydro Carbon - easily influenced by oxigen

Ma	600
Verseke	400
Gym	130
RJL	200
YSKAS	1333
Petrol	450
Spaar	2200
	5303
Wyn	400
Totaal	5700
Wolf	150
hond	200

3500
3800
1300
2200
5600

1280

12

5700

28500

342,00

50.00

392,00