National Exams May 2012

09-MMP-B3, Material Handling

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is a CLOSED BOOK EXAM.
   A Casio or Sharp approved calculator is permitted.

3. Question 1 is **mandatory**.

4. Answer an additional four (4) questions from questions 2 through 7.

5. FIVE (5) questions constitute a complete exam paper.
   The first five questions as they appear in the answer book will be marked.

6. Each question is of equal value (20 marks each)

7. Questions 1 and 3 each have 10 parts of equal value (2 marks each)

8. Questions 2, 4, 5, 6 and 7 have 5 parts of equal value (4 marks each)

9. Most questions require successive calculation steps. Clarity and organization of the answer are important.

10. Last page of exam must be detached by candidate if used for Q3 and submitted in answer book.

09-MMP-B3: Material Handling
Closed book, only non-programmable calculators allowed

Instructions

Answer Question 1 (this is mandatory) plus 4 additional questions only chosen from Questions 2, 3, 4, 5, 6 and 7. Each of the 5 questions you answer are worth equal marks (20% each). Questions 1 and 3 are shorter answer format of 10 parts, each worth 2%. Questions 2, 4, 5, 6 and 7 are longer format (consisting of 5 calculation steps or descriptive answers worth 4% each). Show all working out for maximum marks in calculation type questions.

If you are unsure of the answer (particularly complex calculation questions), but can talk around the question topic to give a sense that you know something about the subject matter and considerations required for the answer, this may allow the examiner to allocate part marks for your response.

Question 1 (MANDATORY QUESTION)

Answer the following in point form, by equation, simple calculation or with a simple diagram with labeling. Do not spend more than 3 minutes on each part.

a. Explain the difference between rolling resistance and grade resistance as it relates to the ability of a truck to move around a mine site.

b. Describe the duty cycle for a dragline.

c. What are 2 examples of continuous mining equipment in a surface mine?

d. What is the purpose of the grooves on a hoist drum?.

e. Explain the problem of material retention and how this affects payload delivery for a haul truck?

f. Briefly explain dozer trapping and how it assists a truck-shovel mining method.

g. Sketch a Koepe hoist system with a tail rope. What is the purpose of the tail rope?

h. In raise boring how is the cut rock moved out of the raise into the haulage below?

i. What is the operational duty cycle difference between a shuttle car and a scooptram.

j. What are 2 advantages of using belly dump haul trucks over rear dump haul trucks.

Question 2

A 500 kW, 80% efficient pump motor is used to power a 0.5 m diameter hydro-transport pipeline up a 1 in 10 gradient, such that 1000 tph solids (dry solid density of 2 t/m^3) is moved in water (density 1 t/m^3) at 2 m/s. If the pressure drop due to potential energy represents 50% of the total pressure drop, the friction factor for the fluid acting on the pipe is 0.005 and that of the solids on the pipe is 0.75, determine:

a. The fluid power that the pump motor must overcome.

b. The total pressure drop that the pump motor must overcome.

c. The solids concentration percentage in the slurry

d. The length of the hydro-transport pipe.

e. The individual pressure drops due to the fluid and solid fractions acting on the pipe respectively.

$$P_f = \frac{fLrv^2}{2\frac{A}{p_r}} \quad P_s = \mu K c L_n g(s-r) \quad P_p = gh[r + c(s-r)] \quad w = pQ \quad T = cAsv$$

Question 3

DETACH <u>PAGE 7</u> OF THE QUESTION BOOKLET AND <u>INCLUDE IN YOUR ANSWER BOOKLET</u>

Using plot X provided on age 7 of this exam booklet; identify, estimate or calculate:

a. The number of shovel load passes
b. The shovel-truck spot time
c. The average shovel pass cycle time
d. The payload recognition tolerance from the 2nd gear reweigh
e. The payload achieved per pass and the total truck payload
f. The shovel dipper capacity at 100% fill factor
g. The truck total cycle time (as reflected by the data and assuming that the outbound and return trips are similar)
h. The distance the truck travels in one cycle, from pit to crusher and back
i. Circle and label any road features you can interpret from the data; e.g. pit, crusher pad, ramps, corners or intersections, providing an average rolling resistance for each of those features.
j. Assuming all road features can be illustrated consecutively in 2-D, sketch a cross section of the pit to crusher road profile with appropriate labeling.

Question 4

A South African underground gold reef mine has a large areal planar 1.5 m thick orebody at a 20 degree dip and maximum of 1.5 km below surface. The ore has a swell factor of 1.3 when fragmented for transportation.

A vertical shaft skip system consistently delivers 1125 tph loose ore to surface with no downtime. The 10 m high, 3 m x 3 m square base skip travels a one-way distance of 1.5 km to surface at a speed of 30 kph. The combined hoisting and lowering time of the system is the same as the combined loading and emptying time of the skip. If the hoisting and lowering velocities of the hoist system are the same and constant, determine:

a. The intact bank density of the ore being transported.

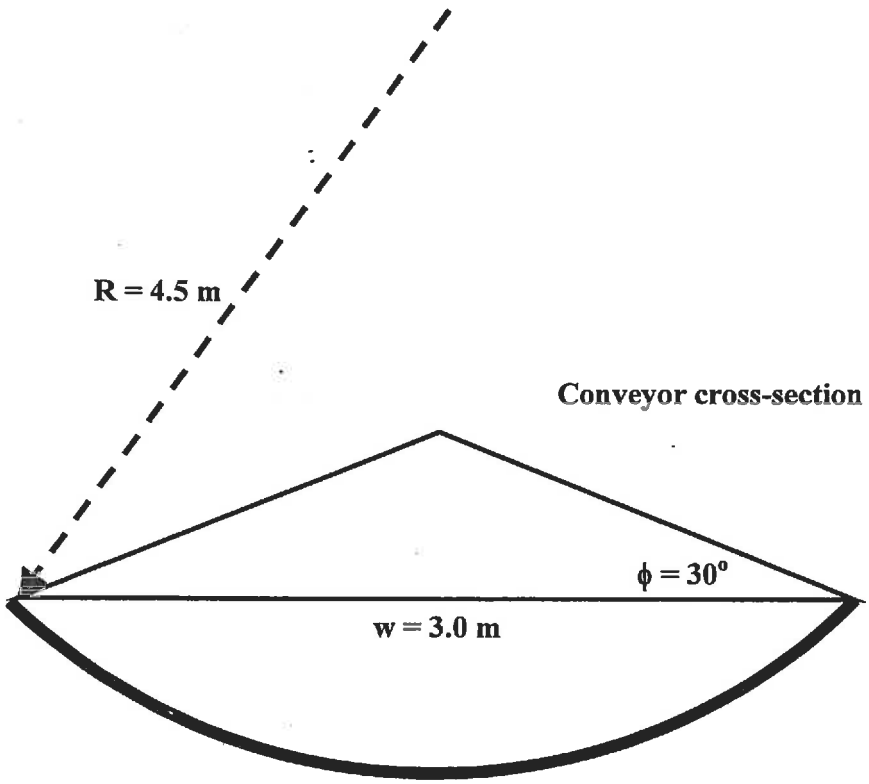
b. If the angle of wrap on a hoist shaft sheave wheel is 120° and the coefficient of friction between the hoist rope and the sheave wheel is 0.4, what is the energy per unit tonne (E/t) required by the hoist drum motor at 85% efficiency if the tare weight of the skip is 50% of the payload?

c. The loading pocket that feeds the shaft skip system is in turn fed using slushers via ore passes. A 60% efficient 0.75 m operational diameter 17.5 kW motor winch pulls a loaded slusher in a gulley (effectively moving a 20 kN load (payload + slusher tare weight)) to an ore pass. If it takes the slusher takes 200 seconds to do the job, what is the distance travelled to the ore pass.

d. What is the rotational speed of the winch in part (c) in rpm?

e. The gulley is fed ore by a hydraulic monitor washing material from the reef stope into the slusher gulley, allowing the slusher to then take over and move the ore to the ore pass. The hydraulic monitor is capable of pushing a 20 cm side "cube" lump of gold ore of density 3.25 t/m^3 down dip at 20° where the wet ore on ore friction coefficient is 0.67. What is the hydraulic pressure required from a 1.5 cm diameter nozzle to just do the job?

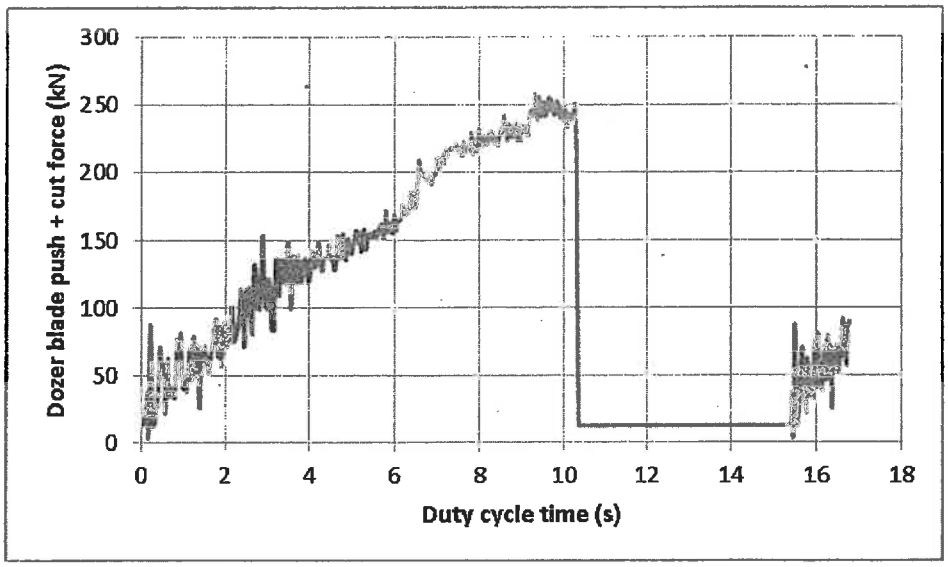
Question 5



A 20 bucket BWE running at 3.75 rpm loads a 4.5 m radius of curvature conveyor belt surface of 3.0 m width, running at 2.5 m/s, carrying ore at a 30° angle of repose over its full width. Each BWE bucket has a fill factor of 1.35 and struck capacity 50% proportionate ring space per bucket. The BWE and conveyor system are matched with the same availability and utilization.

a. Calculate Q_{BWE}?
b. Determine the BWE capacities:
    i. Bucket struck capacity
    ii. Bucket overfill (ring space does not overfill)
    iii. Individual bucket ring space
c. The width of the cut is equal to the width of each "cube" bucket. If the height of the terrace being cut is h, the depth of the cut a; and the slewing velocity of the wheel is a function of w and the number of bucket discharges per second; determine:
    i. The width of the cut, w
    ii. The diameter of the wheel, D (where h = 0.5D, a = 0.1D)
d. Calculate the slewing speed, V_s of the BWE
e. Does it matter if the availability of the BWE is greater than the conveyor system or vice-versa? Comment.

Question 6



A soft near surface lateritic ore mining operation has opted to use Caterpillar D10T 66.5 mt GVW class dozers to trap ore to an apron feeder/at face double roll crusher moving along the bench, below the 30 m high ore face, on a face conveyor. The face conveyor in turn feeds a load out hopper that is tripped by haulers passing underneath such that each hauler is loaded identically. The dozers are equipped with an on-board monitoring system that consistently outputs data of the form given in the figure, such that the total blade push + cut force reaction is shown as a function of cycle time. When minimal forces are recorded, the dozer is reversing to conduct its next cut and push pass. Overall an average of 25% of the total force reaction measured is due to cutting at any instant. If the forces drop to zero, then the dozer has either stalled or stopped.

a. If the dozer effectively reaches maximum cut and push capability with each cycle, what is the coefficient of traction for the ore?

b. If the dozer blade width is twice the height and loose density of the ore is 2 t/lcm, what is the width of the dozer blade?

c. If the blade cuts consistently to 0.2 m depth per pass and the ore swells by 20% on cutting only, what is the base (cut + push) distance to fill the blade?

d. What is the speed of the dozer both in (i) forward and (ii) reverse motion in kph?

e. How many 240 ton truck loads can be nominally loaded by the continuous hopper system per hour (i) if the dozer has an availability of 90%? **And** (ii) how long does the hopper take to load a truck?

Question 7

A 3-phase AC substation, that alone generates 500kW at an 80% power factor, is enhanced by a 70% efficient, 50% power factor rated synchronous motor, which is able to generate an additional useful load of 100 kW.

a. Sketch the power triangles to show:

   i. the lagging substation

   ii. the leading synchronous motor

   iii. the expected resulting (substation + synchronous motor) combination.

b. What is the real power, P of:

   i. the synchronous motor?

   ii. the combination?

c. What is the reactive power, Q of:

   i. the substation?

   ii. the synchronous motor? and

   iii. the combination?

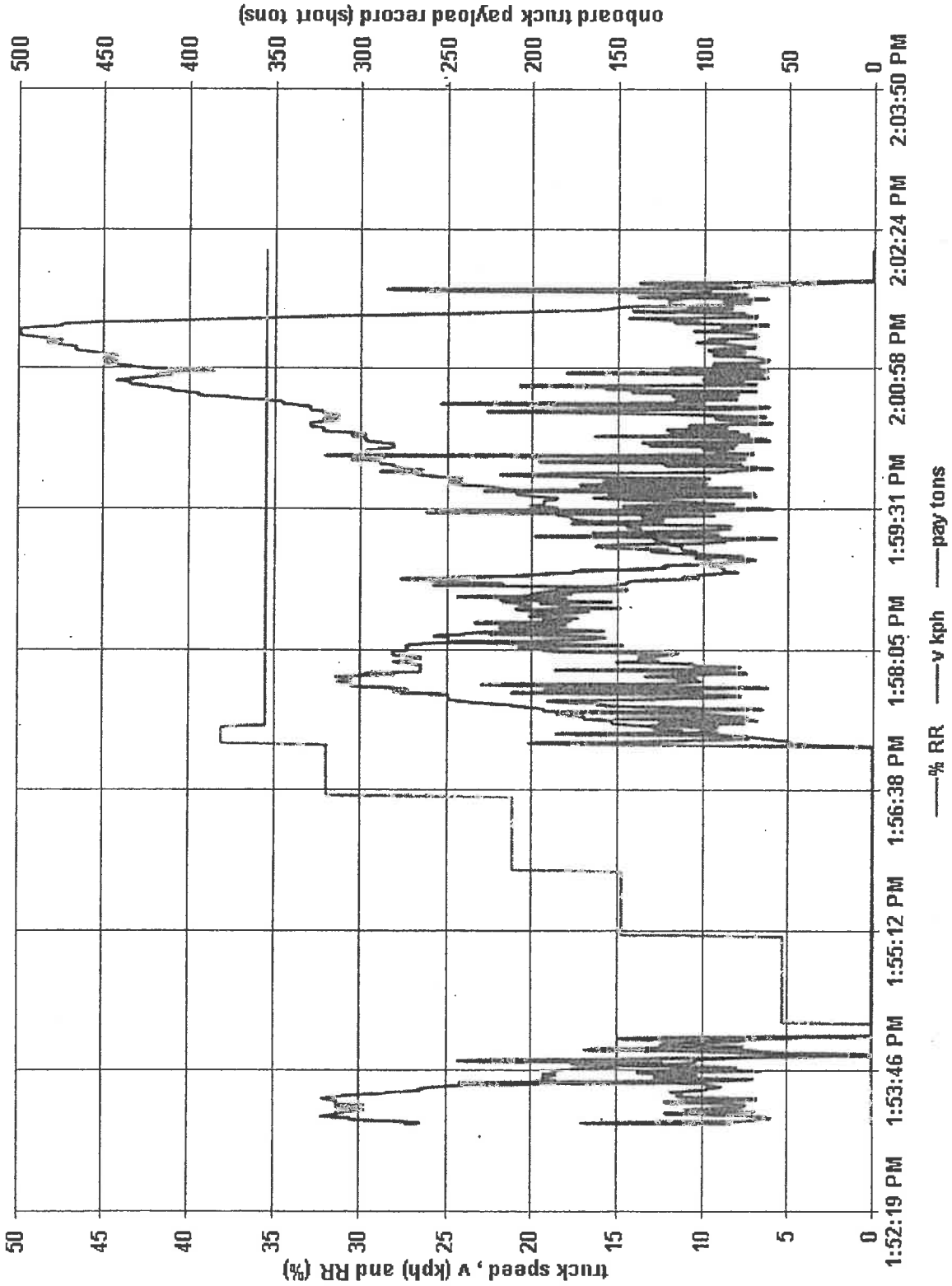
d. What is the power factor of the (substation + synchronous motor) combination?

e. What is the apparent power, S of:

   i. the substation? and

   ii. the combination?

Plot X for Question 3 – DETACH AND INCLUDE WITH ANSWER BOOKLET



Marking Scheme

<u>Question 1 PLUS</u> the first <u>4 additional questions</u> answered will be marked ONLY

1. 20 marks total (10 general questions times 2 marks each) - MANDATORY
2. 20 marks total (5 sections times 4 marks per section)
3. 20 marks total (10 sections times 2 marks per section)
4. 20 marks total (5 sections times 4 marks per section)
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