

EGERTON



UNIVERSITY

UNIVERSITY EXAMINATIONS

NJORO CAMPUS

FIRST SEMESTER 2012/2013

**FOURTH YEAR EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN
AGRICULTURAL ENGINEERING**

AGEN 431: FARM MACHINERY I

STREAM: 2009 (Y4) B. SC. AGEN

TIME: 2 hours

DAY/TIME: Wednesday, 08.30 – 11.30 am

DATE: 16-01-2013

INSTRUCTIONS:

1. The paper contains **FOUR (4)** questions
 2. Attempt **QUESTION ONE** and **any other TWO (2)**.
 3. Marks are shown in parenthesis at the end of each question with a total possible score of 70.
 4. In case of calculations, show all the working steps as well as the relevant units and indicate any assumptions made.
 5. **EACH QUESTION SHOULD BE STARTED ON A NEW PAGE**
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QUESTION ONE (COMPULSORY)

(a) Discuss briefly, the following terminologies as used in agricultural field machines:

- (i) Conventional tillage
- (ii) Conservation tillage
- (iii) Crop planting methods

(12 marks)

(b) A blade tillage tool 36 cm wide and 20 cm long is operating at an inclined angle of 18° at 18 cm depth in a cohesive soil with density equal to 1.55 g/cm^3 , and the angle of soil internal friction of 37.5° . The tool speed is 7.5 k/h, and the soil-metal friction is to be taken as 0.32. Assume soil cohesion equals 45.0 Pa, and specific soil cutting resistance equals 25.0 N/cm. Estimate:

- (i) The horizontal force acting on the tool.
- (ii) The specific draft of the soil

(10 marks)

QUESTION TWO

(a) Differentiate the following terminologies:

- (i) Equipment adjustment and equipment calibration
- (ii) Field capacity and field layout
- (iii) Field efficiency and machinery efficiency
- (iv) Primary tillage and secondary tillage

(8 marks)

(b) Briefly discuss the vertical effects of hitching tillage implements on a tractor

(4 marks)

(c) An unloaded tractor of 13.5 Mg mass has a wheel base of 2.5 m with the centre of gravity acting through a point located 0.85 m ahead of the tractor rear wheel axle and 0.75 m above the horizontal, when resting on level ground. The tractor working on a level ground is pulling a tillage implement through the soil with a force of 47.5 kN. The line of pull is at an angle of 12.5° from the horizontal and passes through a point 0.55 m above the line of reaction of the rear wheel acting at 45 mm ahead of the rear axle. Calculate, under loaded and unloaded conditions:

- (i) Rear wheel reactions.
- (ii) Front wheel reactions.
- (iii) Calculate also, the apparent weight transfer from the front wheels to the rear wheels under the loaded conditions, and
- (iv) The implement pull that will cause 45% weight transfer from the front wheels to the rear wheels.

(12 marks)

QUESTION THREE

(a) Discuss in detail:

- (i) The workshop/lab method used to calibrate a grain drill.
- (ii) The field method for calibrating a maize planter.

(12 marks)

(b) A seed drill has a width of 6.0 m and a drive wheel diameter of 1.2 m. The recommended seed rate for wheat is 125 kg/ha. The germination viability of the available seed is 90%. Calculate:

- (i) The actual seed rate the drill should be set to plant.
- (ii) The number of drive wheel revolutions required to plant 0.1 ha assuming 10% wheel slip.
- (iii) The amount of seed to be collected from each of the 35 seed tubes of the planter for 125 revolutions of the drive wheel.

(7 marks)

(c) A precision planter is to plant maize seeds. The seeds leave the metering device at a downward velocity of 1.5 m/s and fall by gravity through a vertical distance of 75 cm in the drop tube to reach the furrow. The planter forward speed is 7.5 k/h. Neglecting the effects of air resistance and frictional forces in the drop tube, estimate:

- (i) The time taken by the seed to reach the furrow; and

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- (ii) The exit angle required if the seed is to have zero horizontal velocity relative to the furrow. (5 marks)

QUESTION FOUR

- (a) Inter-row cultivators and boom sprayers are common farm machineries used for weed control. Discuss these **two (2)** farm equipment with regard to:

- (i) Main operational components
(ii) Equipment setting procedures for proper operations (12 marks)

- (b) A liquid chemical sprayer with nozzle spacing of 60 cm apart is to be used for spraying at a ground speed of 12.5 km/h. The available 0.875 mm orifice diameter nozzle is rated at 1.50 l/min at a pressure of 350 kPa.

Determine:

- (i) The nozzle flow rate for a hollow cone nozzle for a chemical application rate of 300 l/ha.
(ii) The operating pressure required to produce the desired nozzle flow rate.
(iii) The droplet size at the desired flow rate, if the nozzle produces a volume median diameter (VDM) of 275 μ at 750 kPa.
(iv) The surface tension that should be achieved by adding adjuvant, if a VMD of 350 μ is needed. (12 marks)
