

EGERTON



UNIVERSITY

UNIVERSITY EXAMINATIONS

NJORO CAMPUS

SECOND SEMESTER 2012/2013

**FIFTH YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE
IN MANUFACTURING ENGINEERING AND TECHNOLOGY**

AGEN 534: AGRICULTURAL MACHINERY AND MATERIALS PROCESSING

STREAM: 2008 (Y5) B. SC. MENT

TIME: 2 hours

DAY/TIME: WEDNESDAY, 08.30 – 11.30 AM

DATE: 15/05/2013

INSTRUCTIONS:

1. The paper consists of **FIVE (5)** questions.
 2. Attempt **ALL** questions in **SECTION A** and **ANY TWO** from section B.
 3. Marks for each question are shown in parenthesis.
 4. State any assumptions made and draw clear sketches where necessary
 5. **EACH QUESTION SHOULD BE STARTED ON A NEW PAGE.**
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SECTION A – ATTEMPT ALL QUESTIONS

QUESTION ONE

- (a) Most agricultural machinery operations are normally carried out in farms which unlike workshops present very many challenges. State **THREE** major factors that engineers must consider during the design of agricultural machinery. **(3 marks)**
- (b) The safety portion of the code of ethics for Engineers is fulfilled partially by following product standards written and supervised by appropriate engineering governing bodies.
- (i) Why is it necessary to standardize the hitch points of ploughs? **(1 mark)**
 - (ii) In the design of agricultural machinery and equipment, there are currently **FOUR** main groups that provide the major sources of standards. Name them. **(4 marks)**

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- (c) Standards are technical reports approved and recommended for use by practicing Engineers. Their use is voluntary and no liability is assumed by the sponsoring association for their misuse. State **FOUR** legal issues of product liability where Engineers may not be protected by the direct use of the standards during design of agricultural equipment. **(4 marks)**
- (d) Manufacturers provide a wide variety of tyre types, each intended to suit a particular set of functional requirements. Tyres are classified in categories.
- (i) Use a neat sketch to show the unique features for the following categories of agricultural tyres.
 - Category I. Undriven front steered wheels. **(1 mark)**
 - Category II. Driven rear wheels. **(1 mark)**
 - (ii) Category III tyres are mainly tyres fitted to implements. State **TWO** design characteristics which are unique to this category of tyres. **(2 marks)**
 - (iii) Briefly describe **FOUR** major advantages of using tubeless tyres in agricultural machinery. **(4 marks)**
- (e) The rear drive wheel of a 2WD tractor has the following specifications;
- Tyre size 18.4/175-30
 - During a wheel slip test in a ploughing operation, the distance covered by the drive wheels after 12 complete revolutions were measured as 68.5 m.
- (i) Use a neat sketch to show the following features of the rear wheel.
- Section width (b) **(1 mark)**
 - Rim diameter (d) **(1 mark)**
 - The section height (h). **(1 mark)**
- (ii) From the given rear wheel specifications, determine the following;
- Section width **(1 mark)**
 - Aspect ratio. **(1 mark)**
 - Rim diameter. **(1 mark)**
 - The overall wheel diameter. **(1 mark)**
- (iii) Calculate the wheel slip for the drive wheel in this operation. **(2 marks)**

QUESTION TWO

- (a) The design and construction of a combination seed planter consists basically of seed and fertilizer hoppers, a seed metering mechanism that drops seeds through coulter tubes to the coulters that deposit the seeds to the furrow. All these parts are attached to the main frame.

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- (i) State **TWO** reasons for having vertical partitions inside both fertilizer and seed hoppers. (2 marks)
- (ii) Why are the coulters arranged in a staggered manner? (1 mark)
- (iii) The coulter tubes must be flexible. Why? (1 mark)
- (iv) Each furrow opener is carried on an individual frame which pivots under spring action. Why? (1 mark)
- (b) Use neat sketches to show the following methods used in seed metering in planters
- (i) Centrifugal feed. (1 mark)
- (ii) Cup feed. (1 mark)
- (c) Discuss the standard procedure for static calibration of a seed planter. (3 marks)
- (d) A seed planter has the following features,
- Number of coulter tubes = 24
 - Diameter of the drive wheel = 1.2 m
 - Coulter spacing = 7 cm

During a static calibration test the average yield per coulter tube was found to be 43 gm per revolution of the drive wheel.

- (i) What is the importance of calibrating seed planters before carrying out a planting operation? (1 mark)
- (ii) Determine the operating width of this planter. (1 mark)
- (iii) Calculate the seed rate. (2 marks)

SECTION B – ATTEMPT ANY TWO QUESTIONS

QUESTION THREE

- (a) What do you understand by the term “tillage”? (1 mark)
- (b) Compaction damage is unavoidable during tillage operations. One way of minimizing this is by avoiding high ground contact pressures. Outline **TWO** other factors that should be considered in minimizing compaction. (2 marks)
- (c) A 5 bottom 28 cm mould board plough is used in ploughing 30 cm deep using a 180 kW tractor. The specific resistance of this soil is 18 N/cm^2 . The operation is carried out at 4 km/h. Calculate the following,
- (i) The total pull generated on the tractor during this operation. (1 mark)
- (ii) The necessary drawbar power. (1 mark)
- (d) Name the part of the mould board plough that would allow for the following adjustments/operation during operation.
- (i) The pitch of the plough. (1 mark)

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- (ii) Making the horizontal cut under the furrow slice. (1 mark)
- (e) Disc ploughs are commonly used in the tropics where land preparation is mainly done during the dry season. Briefly outline **FOUR** major advantages of using a disc plough over a mould board plough in the tropics. (4 marks)
- (f) (i) Use a neat sketch to show the arrangement of a 24 discs four gangs in tandem abreast harrow. (1 mark)
- (ii) For the harrow in (f)(i) above, describe **THREE** key 'end of season maintenance' activities that should be carried out before storage of this equipment. (3 marks)

QUESTION FOUR

- (a) (i) State **TWO** main objectives of crop drying and storage. (2 marks)
- (ii) During bulk drying of cereals for storage pre-heated air is passed over thin layers of wet grain. One of the processes used to pass the preheated air utilizes the continuous flow air circulation method. What are the **THREE** methods used to pass the pre-heated air through wet grain in a continuous flow process. (3 marks)
- (b) There are **FOUR** key objectives of applying mechanical separation processes to grain after harvesting. Name them. (4 marks)
- (c) During a filtration process in mechanical separation, the process will continue until there is no more flow. Name **TWO** circumstances that may lead to this state of affairs. (2 marks)
- (d) Using double line symbols draw a well labelled diagram to show a simple sprayer circuit diagram (4 marks)

QUESTION FIVE

- (a) Combine harvesting is an operation performed in sequence by one machine to harvest a crop.
- (i) Briefly explain the major function of the threshing drum and concave during a combine harvesting operation. (1 mark)
- (ii) During the threshing operation, what are the **TWO** important adjustments that must be carried out on the drum and concave? (2 marks)
- (iii) Under what circumstances should the adjustments in (b)(ii) above be done? (1 mark)
- (b) The following measurements were obtained for an empty combine harvester.
- Total combine harvester weight 7850 kg.
 - Total front wheel reactions 1660 kg.

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- Wheel base 5580 mm.

- (i) What are the **TWO** main functions of a reel in a combine harvester? **(2 marks)**
- (ii) Draw a free body diagram showing all forces acting on the combine harvester in stationary condition. **(2 marks)**
- (iii) Determine the rear wheel ground contact normal reaction. **(1 mark)**
- (iv) Calculate the distance from the centre of the rear axle to the combine harvester centre of gravity. **(1 mark)**
- (c) Outline **THREE** important reasons why harvested farm products should be dried before storage. **(3 marks)**
- (d) State **TWO** important factors that must be considered during the design of crop storage silos. **(2 marks)**
