

EGERTON



UNIVERSITY

UNIVERSITY EXAMINATIONS

NJORO CAMPUS

SECOND SEMESTER 2011/2012

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

AGEN 534: AGRICULTURAL MACHINERY AND MATERIALS PROCESSING

STREAM: 2007 (Y5) MENT

TIME: 2 hours

DAY/TIME: Monday, 08.30 – 10.30 am

DATE: 30/04/2012

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 – ANSWER ALL QUESTIONS

QUESTION ONE

- (a) Design, operation and maintenance of agricultural machinery have unique challenges to the Engineer compared to other machines. What are the **TWO** main reasons why this is so? (2 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 agricultural implements world wide? (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)

- (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. As a practicing Engineer you were given the responsibility of designing the hydraulics system of an earth mover's shovel. During its operation, the operator noted a leaking pipe that made it not attain the full pressure making one of the cylinders not to fully extend hence it could not fully empty its contents.

State **FOUR** legal issues of product liability where your design may not be protected by using of the standards directly. **(4 marks)**

- (d) (i) The primary purpose of a wheel is to support a load while moving with minimum resistance over a surface. The wheel is required to produce at its contact with the ground, forces that provide for **FOUR** important characteristic reactions during operation. Name the **FOUR** reactions. **(4 marks)**

- (ii) During operation, tyres must be maintained at the recommended inflation pressure. To achieve this, tyres may be fitted with a separate air container (tube) or be constructed with an integral liner made of a rubber mix which is impervious to air (tubeless). Briefly describe **FOUR** key advantages of using tubeless tyres in agricultural machinery. **(4 marks)**

- (e) The following measurements were obtained from a tractor hitched with a three disc plough during a ploughing operation.

- Total tractor weight is 6850 kg.
- Total front wheel reactions in stationary state before hitching the plough is 1860 kg.
- Tractor wheel base is 2480 mm.

On hitching the plough, the horizontal pull exerted on the tractor during operation was measured as 3560 kg.

- (i) Draw a free body diagram showing all forces acting on the stationary tractor before hitching the plough. **(2 marks)**
- (ii) Determine the rear wheel ground contact normal reaction. **(1 mark)**
- (iii) Calculate the distance from the centre of the rear axle to the tractor's centre of gravity. **(1 mark)**

- (iv) Draw the free body diagram of the tractor during operation at equilibrium state. (2 marks)
- (v) Determine the height from the ground to the tractor top implement hitch point given that the total front normal reaction should not be less than 1320 kg during operation. (1 mark)
- (vi) Briefly explain the effects of the 'weight transfer' component of the pull to the rear drive wheels and front driven wheels of a tractor during operation. (2 marks)
- (vii) Calculate the total weight transfer (addition) to the rear wheels due to the attached implement during operation at equilibrium state. (1 mark)

QUESTION TWO

- (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** modes of air flows used to pass the pre-heated air through wet grain in a continuous flow process? (3 marks)
- (iii) For the three methods in named in (a) (ii) above, use neat sketches to show the movements of hot air currents through the thin grain layers. (6 marks)
- (b) (i) There are **FOUR** key objectives of applying mechanical separation processes to grain after harvesting. State them. (4 marks)
- (ii) Outline the **THREE** main mechanical separations processes used in industry during the processing of agricultural products. (3 marks)
- (iii) A filtration process was used to separate dust particles from air in an air conditioning system. The process worked effectively for eight hours and then stopped. What are the **TWO** main causes of the failure? (2 marks)
- (c) (i) Grain storage facilities are a collection of structures and mechanical devices providing a vital link in the chain between grain producers and users. Briefly explain the **FOUR** key services offered by this value addition chain. (4 marks)
- (ii) There are **FOUR** main factors that one must consider in the layout and design of grain storage and handling facilities or silo buildings. State them. (4 marks)

SECTION B – ATTEMPT ANY TWO QUESTIONS**QUESTION THREE**

- (a) What do you understand by the term tillage in a crop production calendar? **(1 mark)**
- (b) A 5 bottom 28 cm mould board plough is used in ploughing 30 cm deep using a 180 kW tractor fitted dual rear tyres. Each tyre is 420 mm wide. The specific draught of this soil is 18 N/cm². The operation is carried out at 4 km/h.
- (i) What are the **TWO** main reasons for the slow speed of operation when ploughing using the mould board plough? **(2 marks)**
 - (ii) Calculate the total pull for this operation. **(1 mark)**
 - (iii) What is the tractor drawbar power? **(1 mark)**
 - (iv) Determine the tracking intensity on the soil after completion of this operation. **(1 mark)**
- (c) With the help of neat sketches explain how the following components in a mould board plough works.
- (i) Skim coulter. **(2 marks)**
 - (ii) Land side. **(2 marks)**
- (d) Disc ploughs are commonly used in the tropics to perform primary tillage operations. This is due to the soil types and the operation being 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)**
- (e) (i) Use a neat sketch to show the design arrangement of a 24 discs four gangs in tandem abreast harrow. **(1 mark)**
- (ii) For the harrow in (e) (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) The design and construction of a combination seed drill 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.

(i) Both the seed and fertilizer hoppers have vertical partitions. Why is this design necessary? **(2 marks)**

(ii) State **ONE** main reason why the planter coulters are arranged in a staggered manner. **(1 mark)**

(b) Use neat sketches to show the key features in the following seed metering methods for planters.

(i) Centrifugal feed. **(1 mark)**

(ii) Cup feed. **(1 mark)**

(c) (i) Why is it necessary to calibrate a planter before use? **(1 mark)**

(ii) Briefly outline the steps you would follow while calibrating a seed drill in the workshop. **(3 marks)**

(d) A seed drill has the following features,

- Number of coulter tubes = 21
- Diameter of the drive wheel = 1.8 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) Determine the operating width of this seed drill? **(1 mark)**

(ii) Calculate the seed rate. **(2 marks)**

(e) (i) Using double line symbols draw a well labelled sprayer circuit diagram with the control valve switched to the 'ON' position. **(5 marks)**

(ii) What is the need for a power fill in a sprayer? **(1 mark)**

QUESTION FIVE

- (a) Outline **THREE** important characteristics that a crop should exhibit to make it combine harvestable. **(3 marks)**
- (b) The size of the drive wheel of a combine harvester was given as 18.4/175-30. During a harvesting operation, it was found necessary to determine the drive wheel slip in the field. 10 complete revolutions of the drive wheels covered a distance of 62.5 m.
- (i) From the stated specification of the drive wheel, calculate the section width, aspect ratio, rim diameter, and the overall diameter. **(4 marks)**
 - (ii) Determine the wheel slip during this operation. **(2 marks)**
- (c) Briefly outline **ONE** key function of the following parts of a combine harvester during harvesting.
- (i) Drum and concave. **(1 mark)**
 - (ii) Crop lifters. **(1 mark)**
 - (iii) Straw walkers. **(1 mark)**
 - (iv) Feeder house. **(1 mark)**
- (d) State **TWO** important factors that must be considered during the design of crop storage silos. **(2 marks)**
- (e) Outline **THREE** important reasons why farm products should be dried before storage. **(3 marks)**
