THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

2020/2021 ACADEMIC YEAR SUPPLEMENTARY AND DEFFERED FINAL EXAMINATIONS

FEBRUARY, 2022

AEN 4131 FARM STRUCTURES

DURATION: THREE (3) HOURS

INSTRUCTIONS:

ANSWER: FIVE QUESTIONS

INFORMATION

1. THE EXAMINATION PAPER CONTAINS **SIX (6)** QUESTIONS
2. ALL QUESTIONS CARRY **20 MARKS**
3. THE MARKS FOR EACH QUESTION ARE GIVEN IN THE BRACKETS

QUESTION 1

a) Timber is used as a building material in numerous situations. List any THREE factors that make wood a common building material. **(6)**

b) Defects in timber make it unsuitable for certain purposes. Defects are classified according to the time of their manifestation either as natural or those which arise due to poor handling and seasoning. Below is a list of categories of defects that arise from poor handling and seasoning. For each category, mention TWO defects.

i). Defects in timber which has not been converted. **(2)**

ii). Defects due to poor seasoning. **(2)**

iii). Defects due to poor conversion (sawing). **(2)**

c) Use the textural triangle given in Fig. Q1 to determine the texture of the soil with the following particle compositions.

10% sand, 15% clay and 75% silt **(4)**

d) What major problem would one anticipate if one intended to use this soil for making adobe blocks? **(4)**

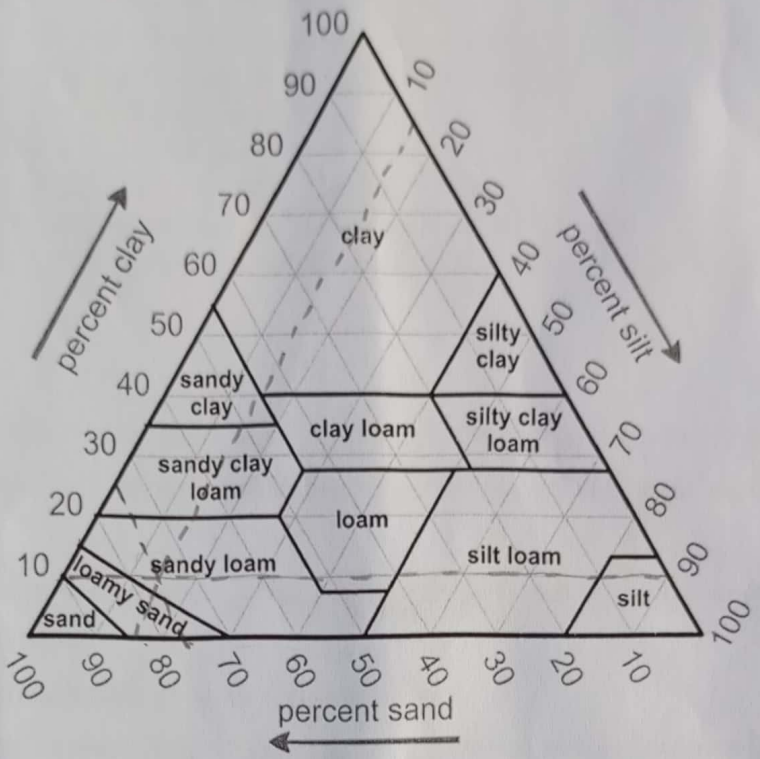

Fig. Q1

QUESTION 2

a) Other than the rate of curing, the effect of temperature, quality of aggregates and placement methods, mention two aspects that greatly affect the strength of concrete. **(2)**

b) A farmer is building a 10 cm thick maize shed concrete slab with a flow plan area of 300 m^2. The farmer has already built the foundation walls and has already backfilled the foundation. You are told to approximate the cost of building the slab. You feel for a maize shed slab a nominal mix of 1:3:5 is ideal.

Properties of the aggregate you intend to buy are as follows:
Moisture content of sand: 2%
Moisture content of stones: 1%
Bulk density of the sand: 1400 kg/m^3
Bulk density of the stones: 1600 kg/m^3

Take the decrease in volume to be 34% and wastage to be 6%

The strength of the concrete is such that the water-cement ratio is 0.6.

Determine:

i) The number of bags of cement to be bought. **(3)**

ii) The number of tonnes of sand to be bought. (3)

iii) The number of tonnes of stones to be bought. (3)

iv) The number of 200L drums of water to be bought. (6)

v) The cost of constructing the slab given the following:
Stones cost K150.00/tonne.
Sand costs K130.00/tonne.
Cement costs K160.00/50kg (37L) bag of cement.
Labour costs are charged per completed slab as K3,500.00.
Water is drawn from the neighbouring farm at a cost of K30.00 per 200L drum. (3)

QUESTION 3

a) Farm structures are in static equilibrium because they do not exhibit linear or rotary motion. List conditions that should be met for a structure to be in static equilibrium. (2)

b) The beam shown in Fig. Q3, has a pin support at A and a (roller) smooth support at B. Determine:

i) The reaction forces at the supports A and B. (3)

ii) Draw the shear force diagram (SFD) and bending moment diagram (BMD). (11)

iii) Give the value of the maximum shear force and state its location. (2)

iv) Give the value of the maximum bending moment and state its location. (2)

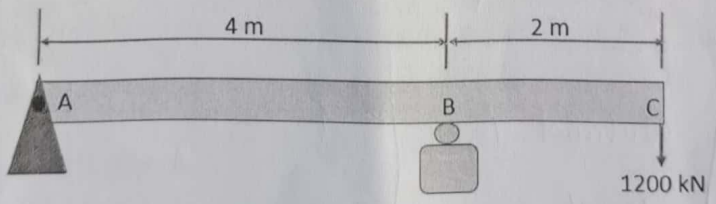

Fig. Q3

QUESTION 4

a) The environment in agricultural buildings affects animal comfort and health and ultimately production. It also influences the quality and longevity of stored products. Mention any FOUR factors that influence the quality of the environment in Agricultural buildings. (4)

b) You are required to raise the temperature of 81 m^3 of air from 10°C and 80% relative humidity (RH) to a final temperature of 32°C. Using the Psychrometric chart provided at the end of the question paper (Fig. Q4), determine:

i) The heat required to raise the temperature. (5)

ii) The relative humidity at the final temperature of 32°C. (5)

100kg of ~~fertilizer~~ = 12 % N

2kg = x

NPK

N : P : K

10 : 25 : 10

4 : 2 : 1

$\frac{10}{100} \times 50kg$

= 5kg N

% N = $\frac{\text{mass of the element in the can}}{\text{mass of the fertilizer}}$

$= CO(NH_2)_2$

= 28.0 g/mol

Fertilizer	Nutrient %
SSP	16.0%
MOP	60.0 %

$Ca(H_2PO_4)_2 \cdot 2H_2O$ = 270.0 g/mol

N : P : K

12 : 16% : 60%

÷2 ÷2 ÷2

4 : 1.3 : 5

$\frac{2 \times 30.9}{66.438 \text{ g/mol}}$

KCl =

74.55 g/mol

100kg of MOP = 60 K_2O

A kg of m = x

100kg of MOP . x =

$Mass_{can}$ = 1kg.

M_{can} = 74.548 g/mol.

$n_{can} = \frac{1000 g}{74.548 g/mol}$

= 13.415 mol

~~Amount of~~

13.415 mol of MOP =

Mass of P =

251.90

50kg of MOP = 60 K_2O

100kg of MOP = 60 kg KCl

c) Ventilation is important in farm buildings such as pig houses. Give any THREE functions of ventilation in a pig house? (6)

QUESTION 5

a) The goal of animal housing design is to produce an environment in which animals are easily handled, fed and can produce without stress or injury. Mention FOUR environmental factors that affect animal production. For each factor give ONE example. (8)

b) Crops can be categorised as durable, semi-perishable and perishable. Mention ONE example crop for each category. (3)

c) Write short notes on how the following factors affect maize storage:
   i). Temperature (3)
   ii). Relative humidity (3)
   iii). Insects and rodents (3)

QUESTION 6

A farmer is planning to start running a pig unit with 20 sows. The farmer practices the following in rearing his pigs:

It takes an average of 15 days from weaning to the day a sow is successfully mated. The gestating sow is taken to the farrowing pen 7days before farrowing. After farrowing, piglets are weaned at 8weeks but remain in the pen till they are 12 weeks. On average, 7 piglets per litter survive to 12 weeks and beyond. After the weaners are removed from the farrowing pens, they take 5 months to grow and fatten. Then, the pigs are sold immediately. Apart from the farrowing pens which house 1 sow per pen, the size of the farmer's other pens is such that a pen can house 8 gestating sows or 10 growing/fattening pigs. After any pen is made empty, it is given 7 days for cleaning purposes before it is reoccupied. You are given that a year has 365 days and a month comprises 30 days.

In the calculation stages, use numbers that are up to 2 decimal places. For final answers, whole numbers without decimal places should be given.

Determine the following with respect to the farmer's pig unit:

a) The number of farrowings per sow per year. (5)

b) The number of farrowing pens the farmer is expected to have. (5)

c) The number of dry sow/gestating sow pens. (5)

d) The number of growing/fattening pens. (5)

* Blood meal can be prepared by
- Solar drying,
- oven drying
- drum drying
- flash drying (spray drying)

- blood meal is high in nitrogen. hence helps the leaf to grow green.

* materials required
- Clean buckets.
- rubber gloves.
* Boil it down
- Dry it out.

Let nothing go to waste.

- oven
- baking sheet.
- oven dry
- Parchment paper.

- boil down the blood for about 2hours to evaporate H_2O from it.
- until H_2O is reduced to 10%
- The method of dry depends on the location.

170 or 180°F.

$$\overline{1}°F = \overline{1}°C \cdot \left(\frac{9°}{5°}\right) + 32.$$

$$\left(\frac{99}{5°}\right) + 32 \qquad \left(\frac{9°}{5°}\right) + 32$$

$$\overline{1}°C = \frac{180°F}{35.8}$$

$$\overline{1}°C = \frac{180°F}{1.8} = 100\%$$

* It is a natural source of nitrogen.
- To much nitrogen leads to leaf burn.
- blood meal is an organic fertilizer.
- Blood looks at exactly 100°C as H_2O.
- 15.0 mins
- non-synthetic source of nitrogen.
- Can be used as pest control in gardens such as rabbits and rats
- it should be processed after slaughtering
- small scale operation needs to be dried to less than 10-12% moisture
- Stored in a dry place in order not to deteriorate.

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SOME USEFUL EQUATIONS

$$\tau_{allowable} \geq \tau_{Max} = \frac{4V_{Max}}{3A} = \frac{16V_{Max}}{3\pi d^2}$$

$$I = \frac{1}{12}bd^3$$

$$\sigma_{Max} = \frac{Mc}{I}$$

$$q = m(h_y - h_x)$$

$$Q = AU\Delta T$$

$$\tau_{allowable} \geq \tau_{Max} = \frac{3V_{Max}}{2A} = \frac{3V_{Max}}{2bd}$$

66.67 Kg of MOP = 40 K_2O /ha
32 Kg Cl /40 ha

66.67 Kg of MOP requirement.

48% of 66.67 Kg KCl /ha.
100%

40 Kg K_2O/ha KCl = 32 Kg Cl/ha.

K_2SO_4 ⟶ K_2O = 50%
S = 17%

40 Kg K_2O /ha.

100 Kg K_2SO_4 = 50% K_2O
4 Kg K_2SO_4 = x

$x = \frac{80 \text{ Kg } K_2SO_4}{2.5}$

S = 17 %

S = $\frac{17\%}{100}$ (80 Kg K_2SO_4)

= 13 Kg S

Area = 10000

* MOP * *
* K_2SO_4

If 40 Kg/ha = recommended

100 Kg MOP = 60 Kg

MOP KCl
* K_2O = 60% *
* K_2SO_4 = 50%

DAP
=

Monoammonium Phosphate.

12 : 61 : 0

$(NH_4^+)_3PO_4$ ≡
$NH_4H_2PO_4$.

$Ca(H_2PO_4)_2 \cdot H_2O$

%m = 23.2%.

SSP = 16%

TSSP = 46%
P_2O_5 = 46%

SSP = 20%
SSP = 18%

* Kainite
*

N : P : K
12 : :

Single super Phosphate.

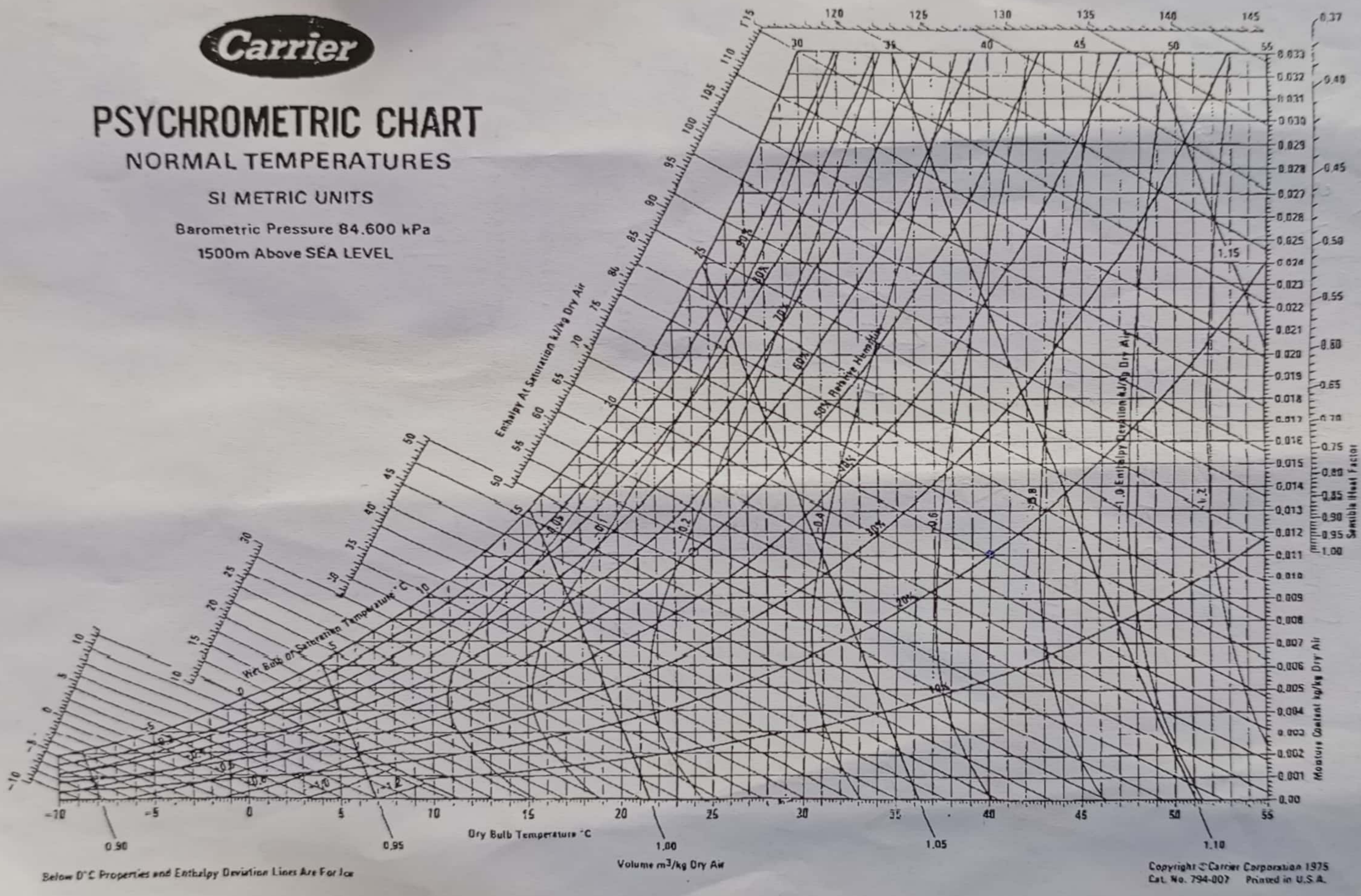

Fig. Q4

% Composition of element = $\frac{\text{Mr Mass of the element in the compound}}{\text{Mass of the compound}}$

~~Number of Pou~~

Pounds of nitrogen in a bag = % recommended (as a fraction) × mass of the bag

$N\% = \frac{18.036 \text{ gm}}{14.09 \text{ kn}} \cdot 14$

Pounds of nitrogen / ha = $\frac{\text{Pounds of nitrogen}}{\text{Area}}$

= 1.288

59.248%

- Cl
- Crash
- Problem

* Fertilizer requirement.

- Area.
- Recommended rate 60kg/ha.

N / ha = $\frac{\text{Recommended rate}}{\text{Area}}$

Amount of N / any given area = N/ha × Area.

Amount to apply in any area = $\frac{\text{Amount of N / area}}{\% \text{ N as a fraction}}$

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Muriate of Potassium (KCl)

macro-nutrient & macron... [ ] $K_2O = 60\%$ } expressed in oxide form - about fertilizer.

Cl = 48%

- element form plant.

$K \times 1.2 = K_2O$

- Chloride have a problem.

K_2SO_4 = ~~80%~~

$K_2O = 50\%$] Macro-nutrients

$S = 17\%$

MoP → 40kg K_2O / ha required → $K_2O = 60\%$ by applying 100kg mop

100kg MoP → 60 Kg K_2O = 60 kg K_2O

* Application of rate 40kg/ha :- how much MoP is required.

Cl 48%

60kg K_2O → 100kg moP.

1 kg K_2O → x

$\frac{60 \text{ kg} \cdot K_2O \cdot x}{60 \text{ kg} \cdot K_2O} = \frac{100 \text{ kg mop}}{60 \text{ kg} \cdot K_2O}$

x = 1.67 moP / K_2O × 40 kg/ha

40 kg K_2O → 66.67 kg moP/ha of required. → 66.66 kg moP / ha. requirement