

THE UNIVERSITY OF ZAMBIA  
SCHOOL OF ENGINEERING  
2020/2021 ACADEMIC YEAR SUPPLEMENTARY AND DEFERRED 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
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**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. (2)
- i). Defects in timber which has not been converted. (2)
  - ii). Defects due to poor seasoning. (2)
  - iii). Defects due to poor conversion (sawing).
- c) Use the textural triangle given in Fig. Q1 to determine the texture of the soil with the following particle compositions. (4)
- 10% sand, 15% clay and 75% silt
- d) What major problem would one anticipate if one intended to use this soil for making adobe blocks? (4)

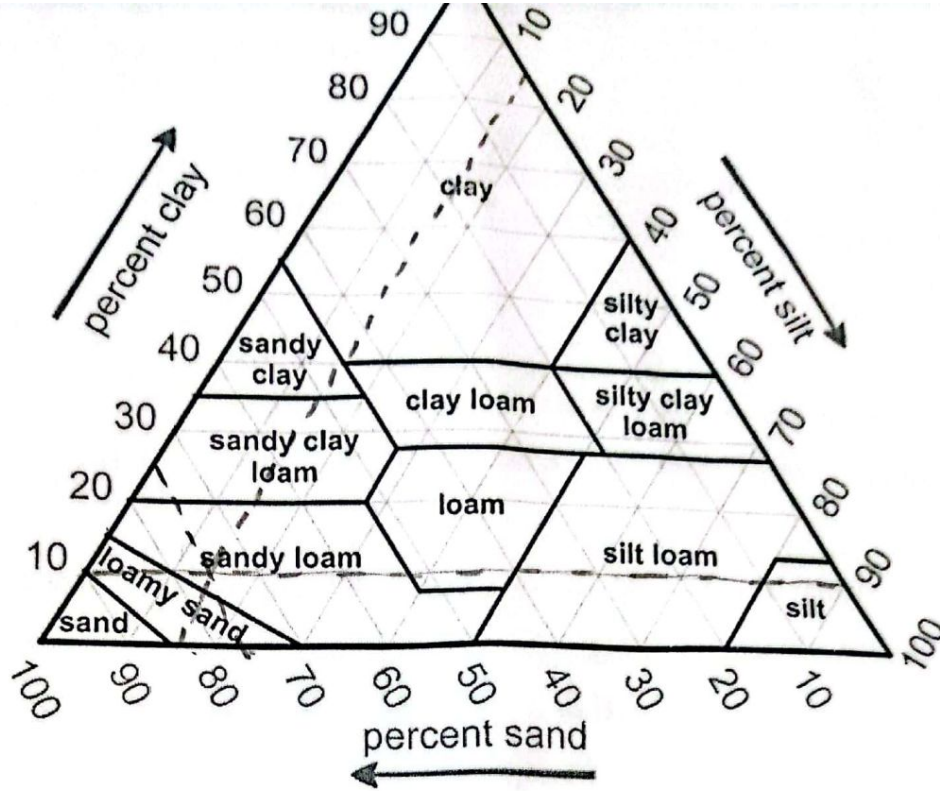


Fig. Q1

## 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<sup>2</sup>. 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<sup>3</sup>

Bulk density of the stones: 1600 kg/m<sup>3</sup>

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: (6)
  - 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)

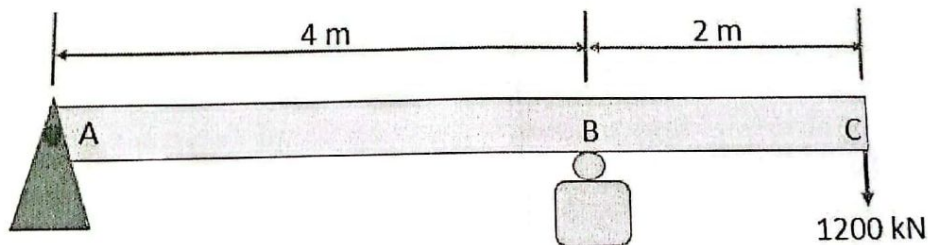


Fig. Q3

### 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  $81 \text{ m}^3$  of air from  $10^\circ\text{C}$  and 80% relative humidity (RH) to a final temperature of  $32^\circ\text{C}$ . 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  $32^\circ\text{C}$ . (5)

- 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 7 days before farrowing. After farrowing, piglets are weaned at 8 weeks 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: (5)
- 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)

## SOME USEFUL EQUATIONS

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

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

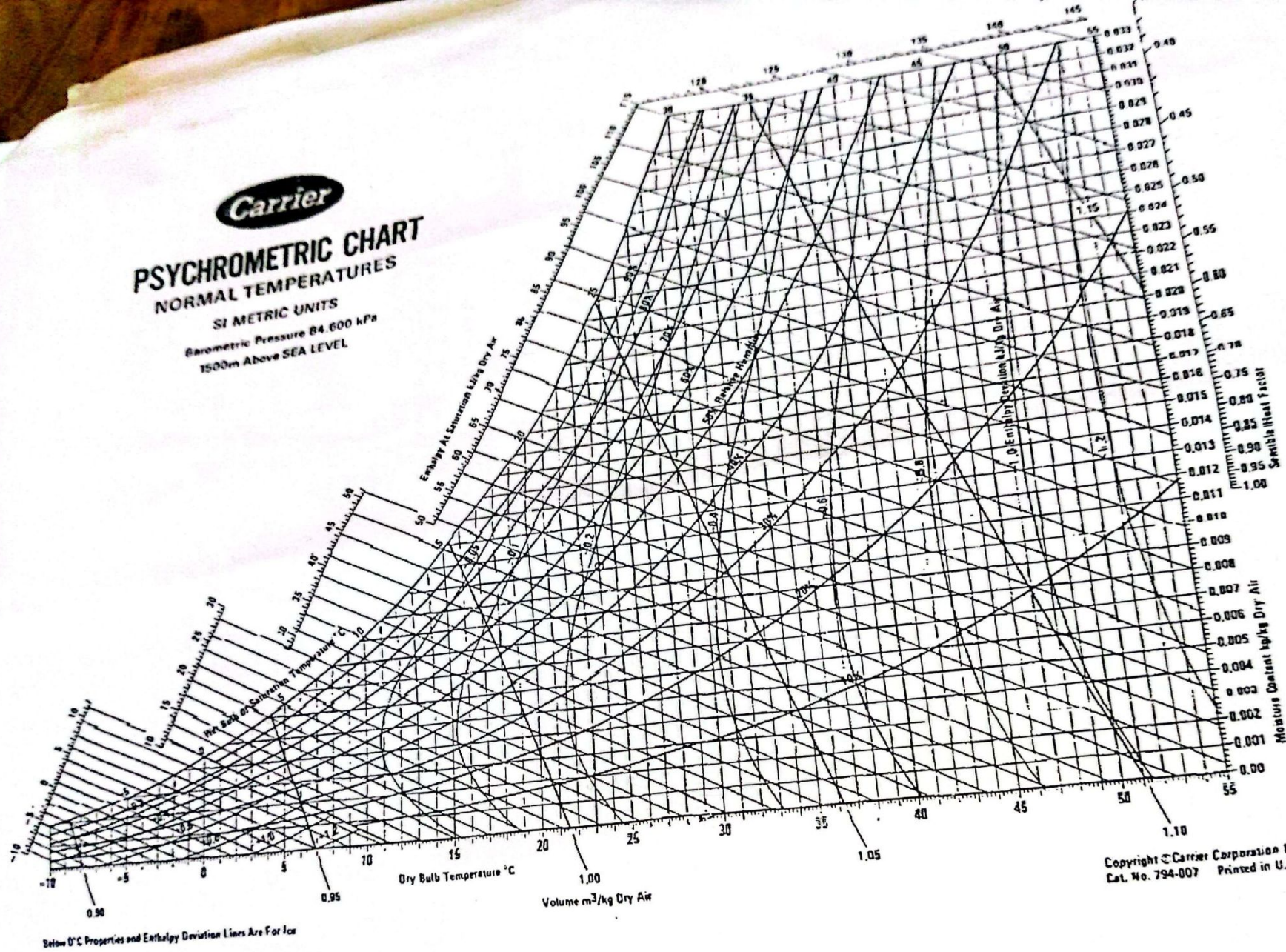
$$Q = AU\Delta T$$

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

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

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

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Fig. Q4