QUESTION 5

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) Ventilation is important in farm buildings such as poultry houses. Give FOUR aspects of poultry houses that are accomplished through ventilation. **(4)**

c) Flesh moist air is entering a poultry house at 10°C and 70% relative humidity (RH). The moist air is replacing the fouled air removed from the house by an exhaust fan. If the fouled air is removed at a rate of 2 m^3/s, a temperature of 25°C and 70% RH. Using the Psychrometric chart provided at the end of the question paper (Fig Q5), determine:

i) The density of the moist air as it enters the poultry house. **(4)**

ii) Sensible heat per hour added to the air inside the poultry house. **(4)**

iii) Latent heat per hour added to the air inside the poultry house **(4)**

QUESTION 6

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) How do insects and rodents affect the safe storage of durable crops? **(3)**

c) With respect to the storage of perishable crops, write short notes on the following:

i). Temperature **(3)**

ii). Relative humidity 80 - 95% is ideal (optimal), **(3)**

QUESTION 7

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF AGRICULTURAL ENGINEERING

2019/20 UNIVERSITY DEFERRED EXAMINATIONS

AEN 4131: FARM STRUCTURES

TIME ALLOWED: THREE (3) HOURS

INSTRUCTIONS:

1. THIS EXAMINATION PAPER HAS **FIVE (5)** QUESTIONS.
2. ANSWER **ALL** QUESTIONS IN ANY ORDER BUT CLEARLY INDICATE THE QUESTION NUMBER ON THE ANSWER BOOKLET
3. ALL QUESTIONS CARRY EQUAL MARKS (20 MARKS EACH).
4. THE MARKS FOR EACH SUB-QUESTION ARE GIVEN IN BRACKETS.

QUESTION 1

(a) As a farm building specialist, briefly explain why you are an integral part of a farming enterprise?

[5 marks]

(b) List any **six (6)** examples of farm structures.

[6 marks]

(c) A wooden box that measures 520 mm long, 44 mm wide and 50 mm high has been used to carry out a bar shrinkage test. Determine the minimum shrinkage (in mm) of dry bar expected after the test if the soil is to be declared stable.

[5 marks]

(d) If the soil in Question 1 (c) was declared unstable during the bar shrinkage test, list any **four (4)** soil stabilizers that may be added to improve its properties as a building material?

[4 marks]

QUESTION 2

(a) List any **six (6)** factors that make timber a popular building material in many parts of the world.

[6 marks]

(b) Briefly describe the durability of timber as a building material.

[5 marks]

(c) Distinguish a wane from a want with respect to timber defects.

[4 marks]

(d) Briefly describe the main use of timber as a building material.

[5 marks]

QUESTION 3

(a) Briefly describe the **three (3)** main constituents of fresh concrete.

[6 marks]

(b) Thirty-three litres (33L) of water have been added to a nominal concrete mix whose mix ratio is 1:3:6. The existing moisture content for sand and stones in this mixture is 4.5% and 1.8% respectively. The associated bulk density for sand is 1400 kg/m^3 that of stone is given as 1600 kg/m^3. If 0.32 m^3 of sand and 0.44 m^3 of stone are the volumes calculated for this mix, determine the total amount of water (in kg) that is contained in the mixture. Assume water density of 1 kg/L.

[8 marks]

(c) Workability of concrete is defined as the ease with which a concrete mix can be handled from the mixing point to its finally compacted shape. Briefly describe the **three (3)** main characteristics of this property of concrete.

[6 marks]

QUESTION 4

(a) List any **five (5)** applications of steel in farm structures.

[5 marks]

(b) List any **five (5)** types of dead loads that may exist in farm structures.

[5 marks]

(c) A farm building contains air with a specific volume of 1.00 m^3/kg dry air and a relative humidity of 40%. Using a psychrometric chart of 1500 m above sea-level attached, state the missing **five (5)** parameters as well as their values and correct units that correspond to the above mentioned specific volume and relative humidity as they appear on the chart.

[10 marks]

QUESTION 5

(a) A pig production unit has 14 sows in which the average suckling period is 8 weeks. Piglets remain in the farrowing pens for 4 weeks after weaning and 1 week is required for cleaning and sanitation before farrowing. The average weaning to conception period is 20 days, while the gestation period is 114 days. The sows are moved to the farrowing pens 1 week before farrowing, but 7 days must be added for cleaning in the servicing/gestation pens.
Two-stage growing and finishing is practised with growing pigs remaining in the growing pen from 12 to 20 weeks of age and in the finishing pen from 20 to 27 weeks of age. 1 week is required in the growing pen for cleaning and sanitation. Two (2) weeks are required for selling off the finished pigs and 1 week for cleaning the finishing pen. If the sows farrow twice every year with only 8 pigs/litter surviving to both 12 and 20 weeks of age, determine:

i) The number of servicing/gestation pens if each houses 4 sows.

[5 marks]

ii) The number of growing pens if each houses 10 pigs.

[5 marks]

(b) Describe the nature of activities expected in the labelled zones **1, 2, 3, 4** and **5** on the farmstead plan given in Figure Q5b.

[10 marks]

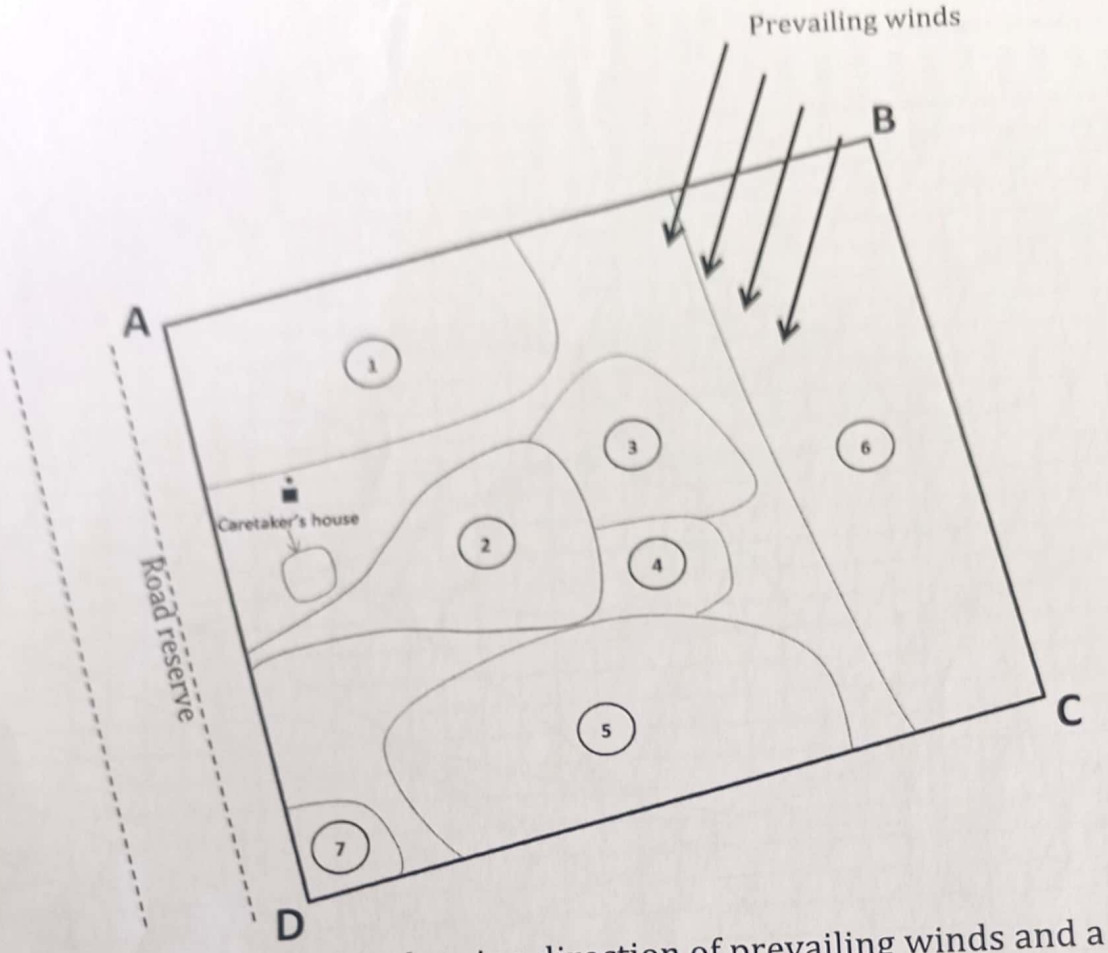


Figure Q5b; Farmstead Zone plan showing direction of prevailing winds and a road reserve.

Planning Stages !
(i) Conception & feasibility
(ii) Sketch design
(iii) Detailed designing
(iv) prepare working drawings
(v) " bill of materials
(vi) Invite tenders from Contractors
(vii) Site operation.

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
2017/18 ACADEMIC YEAR FIRST TERM TEST II

JUNE, 2018

AEN 4131 – FARM STRUCTURES

TIME: TWO (2) HOURS

INSTRUCTIONS:

ANSWER **ALL** QUESTIONS

INFORMATION:

1. EACH QUESTION CARRIES **25 MARKS**
2. THE MARKS FOR EACH SUB-QUESTION ARE GIVEN IN BRACKETS

QUESTION 1

(a) Explain how compromising the quality of environments in commercial farm buildings may have undesired effects on:
i) Egg poultry farming (3)
ii) Fresh mango fruit storage (3)

(b) State any **four (4)** functions of ventilation in buildings. (4)

(b) With an aid of a diagram, describe the *'Stack effect'* associated with natural ventilation in farm buildings. (6)

(c) List any **two (2)** psychometric chart parameters that are dynamic and **one (1)** that remains constant during each of the processes listed below:

i) Sensible heating (3)
ii) Sensible cooling (3)
iii) Evaporative cooling (3)

QUESTION 2

(a) What are the **three (3)** main components of a mechanical ventilation system? (3)

(b) An enclosed crop storage bin contains 81m^3 of air. A dry bulb thermometer inside the bin reads 10°C and a hygrometer in the same structure indicates a relative humidity of 80%. Using the 1500m above sea level psychrometric chart;
i) Determine the amount of heat required to achieve a thermometer reading of 28°C. (8)
ii) Predict the relative humidity reading expected on the hygrometer once the conditions in part (b) (i) above are attained. (2)

(c) A farmer intends to develop poultry units for egg production. As a consultant, you have been hired to present two systems, i.e. the deep litter and cage systems. Briefly outline the main differences between these two systems. (8)

(d) State and explain any **two (2)** functional design requirement guidelines that may be used to ensure good plans are developed on a farmstead. (4)

QUESTION 3

(a) The final stage of functional planning for farmsteads involves site operations. What are the main activities executed during this stage? (6)

(b) A pig production unit has 35 sows in which the average suckling period is 8 weeks. Piglets remain in the farrowing pens for 4 weeks after weaning and 1 week is required for cleaning and sanitation before farrowing. The average weaning to conception period is 20 days, while the gestation period is 114 days. The sows are moved to the farrowing pens 1 week before farrowing, but 7 days must be added for cleaning the servicing/gestation pens.

Two-stage growing and finishing is practised with growing pigs remaining in the growing pen from 12 to 20 weeks of age and in the finishing pen from 20 to 27 weeks of age. One week is required in the growing pen for cleaning and sanitation. Two weeks are required for selling off the finished pigs and 1 week for cleaning the finishing pen. Assume that 10 piglets survive to finishing. If the number of farrowing's per year is 1.9, determine:

i) the number of farrowing pens. (4)

ii) the number of servicing/gestation pens each housing 4 sows. (5)

iii) the number of growing pens with 10 pigs each. (5)

iv) the number of finishing pens with 8 pigs each. (5)

QUESTION 4

(a) An effective zone plan for a new farmstead has been sketched as shown in figure 1. Briefly explain the nature of the function and/or activity expected in the areas marked 1, 2 3, 4 and 5. (10)

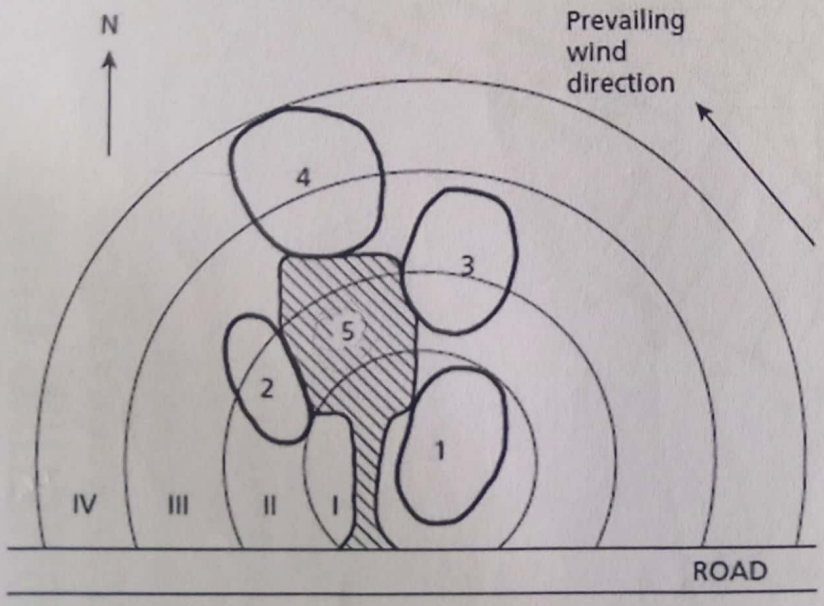


Fig. 1: Zonal planning of a new farmstead.

(b) Distinguish bag from bulk grain storage. (7)

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

2017/18 ACADEMIC YEAR UNIVERSITY EXAMINATIONS

TERM 1, JULY 2018

AEN 4131: FARM STRUCTURES

TIME ALLOWED: THREE (3) HOURS

INSTRUCTIONS:

1. THIS EXAMINATION PAPER HAS **SIX (6)** QUESTIONS.
2. ANSWER ANY **FIVE (5)** QUESTIONS.
3. ALL QUESTIONS CARRY **EQUAL MARKS** (20 MARKS EACH).
4. THE MARKS FOR EACH SUB-QUESTION ARE GIVEN IN BRACKETS.

QUESTION 1

a) List any **four (4)** factors that should be considered when choosing a preservative.

[4 marks]

b) Briefly discuss how timber is used in the following situations, giving examples of specific applications, the form in which timber is used and indicate the basic requirements of the timber under each application.

i) Constructional work;

[4 marks]

ii) False work carpentry; and

[4 marks]

iii) Finishing joinery

[4 marks]

c) State two advantages and two disadvantages of **thatch** as a roofing material for buildings in rural areas.

[4 marks]

37 ✓

QUESTION 2

a) Briefly explain the following terms with respect to fresh concrete:

i) Workability

[4 marks]

ii) Stability

[4 marks]

(b) Given that a concrete mix has a cement:sand:stone ratio of 1:3:5 by volume using naturally moist aggregates and that 2 bags of cement (each weighing 50kg) and 62 litres of water are used in the mix. Calculate:

i) The volume of ingredients

[3 marks]

ii) The water to cement ratio by weight

[3 marks]

iii) The solid volume of the concrete, excluding air voids in the materials.

[3 marks]

iv) The reduction in volume between the mixture and the sum of the separate volumes of ingredients.

[3 marks]

Additional information:
Moisture content of sand: 4%
Moisture content of stones: 1.5%
Bulk density of the cement: 1351 kg/m³
Bulk density of the sand: 1400 kg/m³
Bulk density of the stones: 1600 kg/m³
Solid density of aggregate materials: 2650 kg/m³
Solid density of cement: 3100 kg

0·222
0·37 = 0·04625
8

QUESTION 3

a) A farmer is using a simply supported beam to hoist an engine weighing 6 kN from a tractor. The simplified beam and hoist arrangement is shown in Figure 3 below.

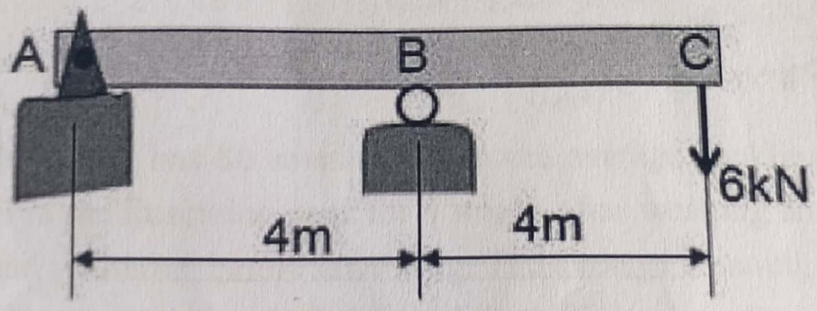


Figure 3

i) Determine the supporting reactions on the beam points A and B.

[6 marks]

ii) Draw the shear force and bending moment diagrams for the beam.

[10 marks]

iii) State the location and the maximum value of the shear force and the bending moment.

[4 marks]

QUESTION 4

a) An effective zone plan for a new farmstead has been sketched as shown in figure 4. Briefly explain the nature of the function and / or activity expected in the concentric circle zones labelled I, II, III, and IV.

[12 marks]

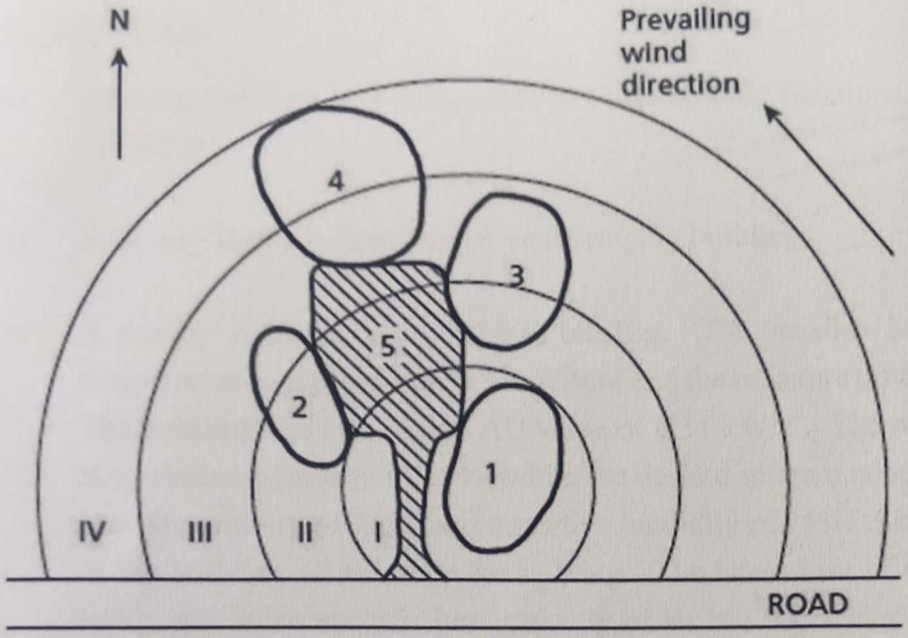


Fig. 4: Zonal planning of a new farmstead.

b) When choosing a site for farm buildings, several factors must be taken into account. Outline any **four (4)** of these factors.

- Topography
- climate
- soil mechanics
- waste management
- services

[8 marks]

QUESTION 5

a) A pig production unit has 80 sows in which the average suckling period is 8 weeks. Piglets remain in the farrowing pens for 4 weeks after weaning and 1 week is required for cleaning and sanitation before farrowing. The average weaning to conception period is 20 days, while the gestation period is 114 days. The sows are moved to the farrowing pens 1 week before farrowing, but 7 days must be added for cleaning the servicing/gestation pens.

Two-stage growing and finishing is practised with growing pigs remaining in the growing pen from 12 to 20 weeks of age and in the finishing pen from 20 to 27 weeks of age. One week is required in the growing pen for cleaning and sanitation. Two weeks are required for selling off the finished pigs and 1 week for cleaning the finishing pen. Assume that 8 piglets survive to finishing, determine:

i) the number of farrowing's per year.

[5 marks]

ii) the number of farrowing pens.

[5 marks]

iii) the number of servicing/gestation pens each housing **5** sows.

[5 marks]

iv) the number of boar pens if each boar services **16** sows.

[5 marks]

QUESTION 6

a) All farm buildings are designed to perform specific functions. List any **five (5)** of these functions.

[5 marks]

b) State any **four (4)** functions of ventilation in buildings.

[4 marks]

c) A poultry building houses 2,000 broilers. The sensible heat production at ambient temperature is approximately 8.4 W/bird and the moisture production is 6 g/hour per bird. The building has an average AU value of 0.34 kW/K. The outside temperature is 15°C at a relative humidity of 70%, while the desired internal conditions must be maintained at a temperature of 25°C and a relative humidity of 75%. Six 100 W light bulbs are on in the building all the time for lighting. The latent heat of water vaporisation is 2454 kJ/kg, while the specific heat capacity of air is 1.005 kJ/kg°C. Use the psychrometric chart for 1500m above sea level to find:

i) the total heat gain in the building assuming that all moisture produced by the birds can evaporate.

[5 marks]

ii) the minimum ventilation rate required to maintain the desired relative humidity.

[2 marks]

d) Explain the function of grain storage in the economy?

[4 marks]

LIST OF EQUATIONS

$Q = EAV$ $Q = VA$ $V = \varphi\,[(2gh\,(T_i - T_o/T_i)]^{1/2}$

$q_s + q_e + q_{sup} \pm q_l - q_B = q_{vi} - q_{vo}$ $q_v = q_s + q_{sup} - q_w - q_b\; q_v = q_s - q_b$

$q_l = MNh_{fg}$ $mC_p\Delta T = q_s - \sum AU\Delta T$ $MN + mW_o = mW_i$

$m(h_i - h_{tp}) = q_l q_v = mCp\Delta T$ $q_B = \sum AU\Delta T$

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
2017 ACADEMIC YEAR MID-YEAR FINAL EXAMINATIONS

MAY, 2017

AEN 4131 FARM STRUCTURES

TIME: THREE (3) HOURS

INSTRUCTIONS:

ANSWER: FIVE QUESTIONS

INFORMATION

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

QUESTION 1

(a) List two (2) functions of each of the following building elements:

(i) Floor.
(ii) Foundation.
(iii) Roof. (6)

(b) Briefly describe using a sketch the process of laying of roofing sheets. (8)

(c) Discuss the use of thatch as a roofing material giving its properties and treatment, and its disadvantages and advantages in relation to other types roofing materials. (6)

QUESTION 2

(a) Figure 2 below shows typical seasoning defects in timber. Identify each defect and its cause. (7)

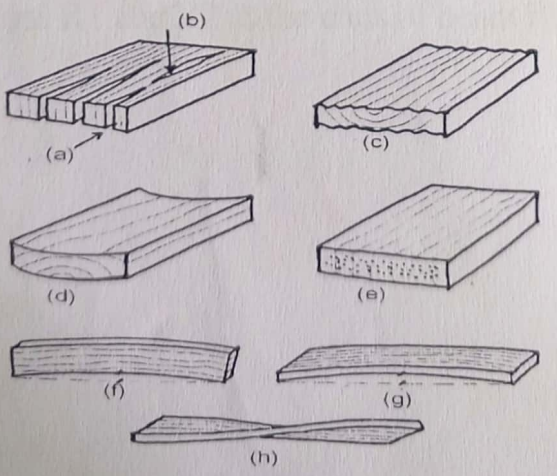


Figure 2

(b) Explain the use of the following preservatives for timber (3)

(i) Creosote
(ii) Un-leachable metallic salts
(iii) Organic solvents

(c) A 100 mm thick concrete floor slab is required for a building. The mix ratio is 1:3:6 by volume and 8 bags of cement (50 kg) are used. The water cement ratio by weight is equal to 0.65. Assume a decrease in volume of 30% from constituent materials to the finished concrete volume. Further, assume the following:

Moisture content of sand = 3.5%
Moisture content of stone = 1.7%
Bulk density of cement = 1351 kg/m^3
Bulk density of sand = 1400 kg/m^3
Bulk density of stone = 1650 kg/m^3

Work out the amount of water to be added and the floor area that can be covered by the fresh concrete. **(10)**

QUESTION 3

(a) Briefly discuss the following types of loads in Agricultural buildings:

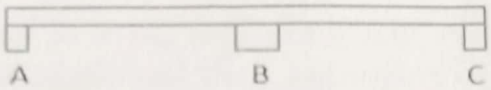
(i) Dead loads;
(ii) Live loads; and
(iii) Wind Loads. **(12)**

(b) Consider a suspended floor where loads are supported by a set of equally spaced beams Fig. 3. If the uniformly distributed load arising from the floor itself and the weight of any material placed on top of it (e.g. stored maize) is 15 kN/m^2. Determine:

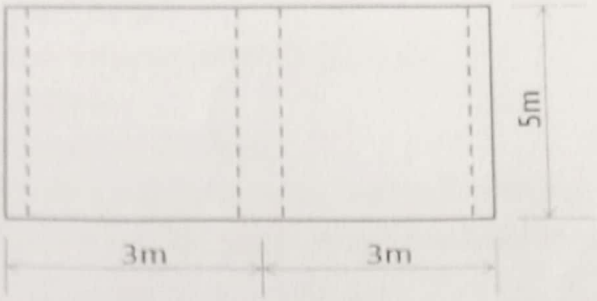
(i) the total load supported by beam B. **(3)**
(ii) the uniformly distributed load Q (kN/m) supported by beam B. **(2)**
(iii) the reactions R1 and R2 at the ends of beam B. **(3)**

$1m^3 = 1000L$
32

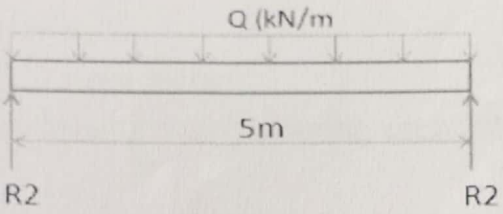
Floor Section



Floor Plan



Beam B



QUESTION 4

(a) In an evaporative cooling installation, outside air at 35°C dry bulb temperature and 15 g/kg absolute humidity is passed through wet pads until the inside air becomes saturated. Use the attached psychrometric chart to determine:

(i) the amount of heat converted from sensible heat to latent heat in this process if the latent heat of water vaporization is 2454 kJ/kg; **(4)**

(ii) the dry bulb temperature in the room; and **(2)**

(iii) how much heat energy would be supplied and what the new relative humidity will be if, in order to improve the conditions further, the air is re-heated to 25°C using a filament heater. **(4)**

(b) A naturally ventilated pig building is 30m long, 12m wide and has a 2.4m high side-wall. This naturally ventilated structure has a 0.080 m eaves opening along one side and an 0.080 m wide ridge opening and no ceiling. The difference in height between inlet and outlet is 2m. The outside temperature is 16°C and the inside temperature is 25°C Consider $E = 0.35$ and $\theta = 0.63$. The wind speed is 5.2 m/s. Use Figure 4a and 4b where appropriate to determine:

(i) the ventilation air flow rate due to wind. **(3)**

(ii) the ventilation air flow rate due to thermal effects **(4)**

(iii) the ventilation air flow rate due to combined effects. **(3)**

QUESTION 5

A farmer is intending to invest in a pig production unit with 100 sows and will practice an eight (8) week weaning period. Each pen should be occupied at all times except for a period of one week for cleaning and sanitation. The farmer will also practice single stage finishing of pigs from 12 weeks to 27 weeks of age. The following periods must also be considered:

An average weaning to conception period of 20 days;
A gestation period of 114 days;
A period of rearing of weaners of 28 days;
Sows are brought to farrowing pens one week before farrowing; and
An extra period of 21 days for the last pig to reach marketable weight.

Assuming that ten (10) piglets survive per litter, ***determine***:

(a) the number of farrowing's per year. **(4)**

(b) the number of farrowing pens. **(5)**

(c) the number of servicing/gestation pens. **(5)**

(d) the number of growing/finishing pens assuming each litter occupies one pen. **(6)**

QUESTION 6

(a) Briefly discuss the role of storage in the economy. **(3)**

(b) Briefly discuss the following types of Rural Settlements:

(i) Clustered Rural Settlements. **(3.5)**

(ii) Dispersed Rural Settlements. **(3.5)**

(c) Outline any **five (5)** factors to consider when undertaking site selection for various buildings on a Farmstead. **(10)**

LIST OF EQUATIONS

$Q = EAV$ $Q = VA$ $V = \varphi\,[(2gh\,(T_i - T_o/T_i)]^{1/2}$

$q_s + q_e + q_{sup} \pm q_l - q_B = q_{vi} - q_{vo}$ $q_v = q_s + q_{sup} - q_w - q_b\; q_v = q_s - q_b$

$q_l = MNh_{fg}$ $mC_p\Delta T = q_s - \sum AU\Delta T$ $MN + mW_o = mW_i$

$m(h_i - h_{tp}) = q_l\, q_v = mCp\Delta T$ $q_B = \sum AU\Delta T$

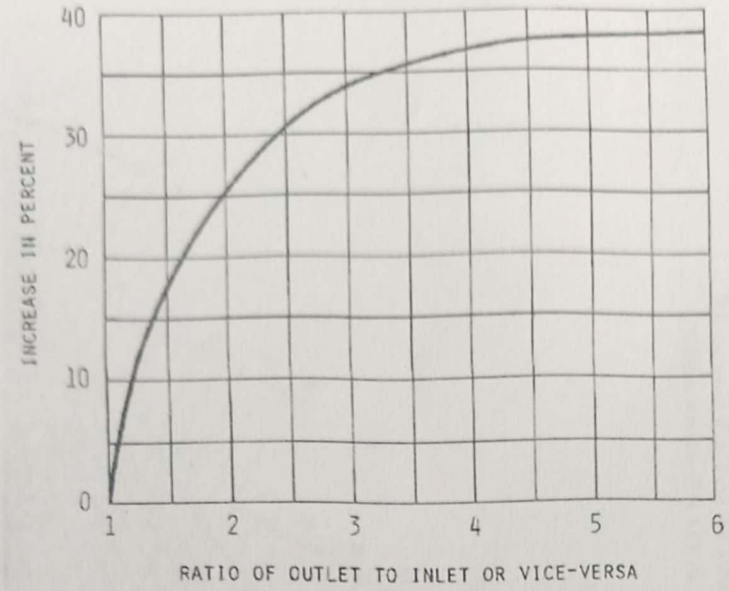


Figure 4a: Increase in flow caused by excess of one opening over another (from ASHRAE)

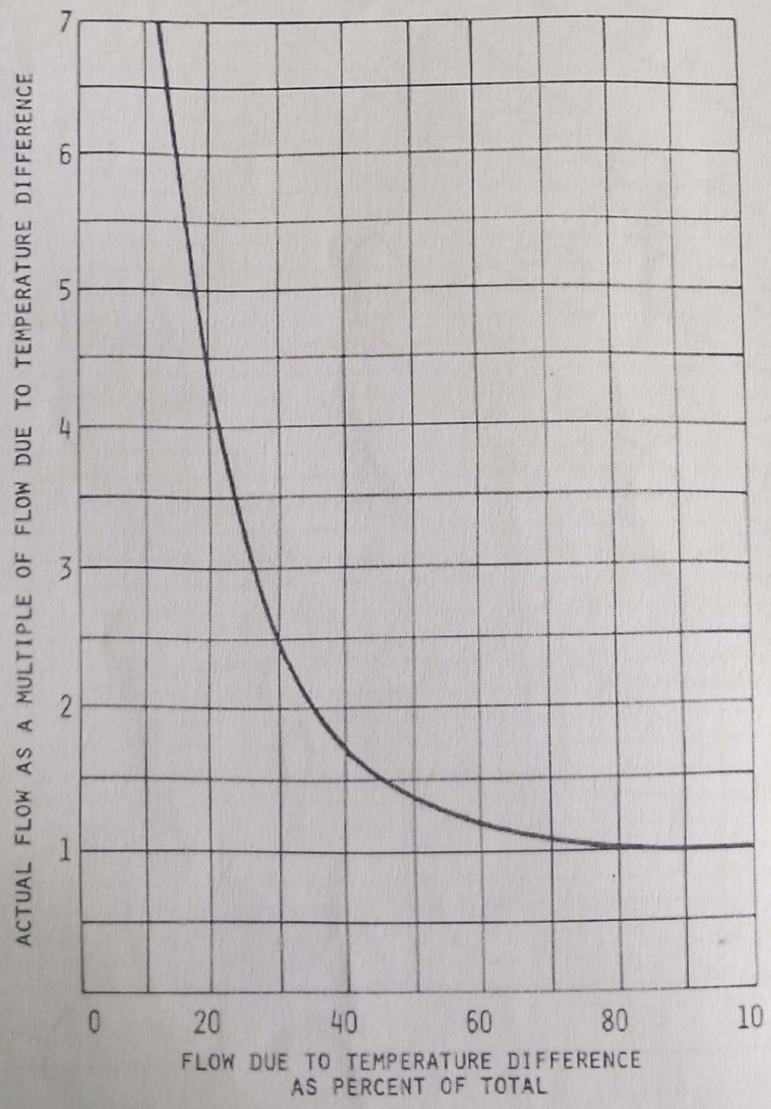


Figure 4b: Determination of flow caused by combined forces of wind and temperature

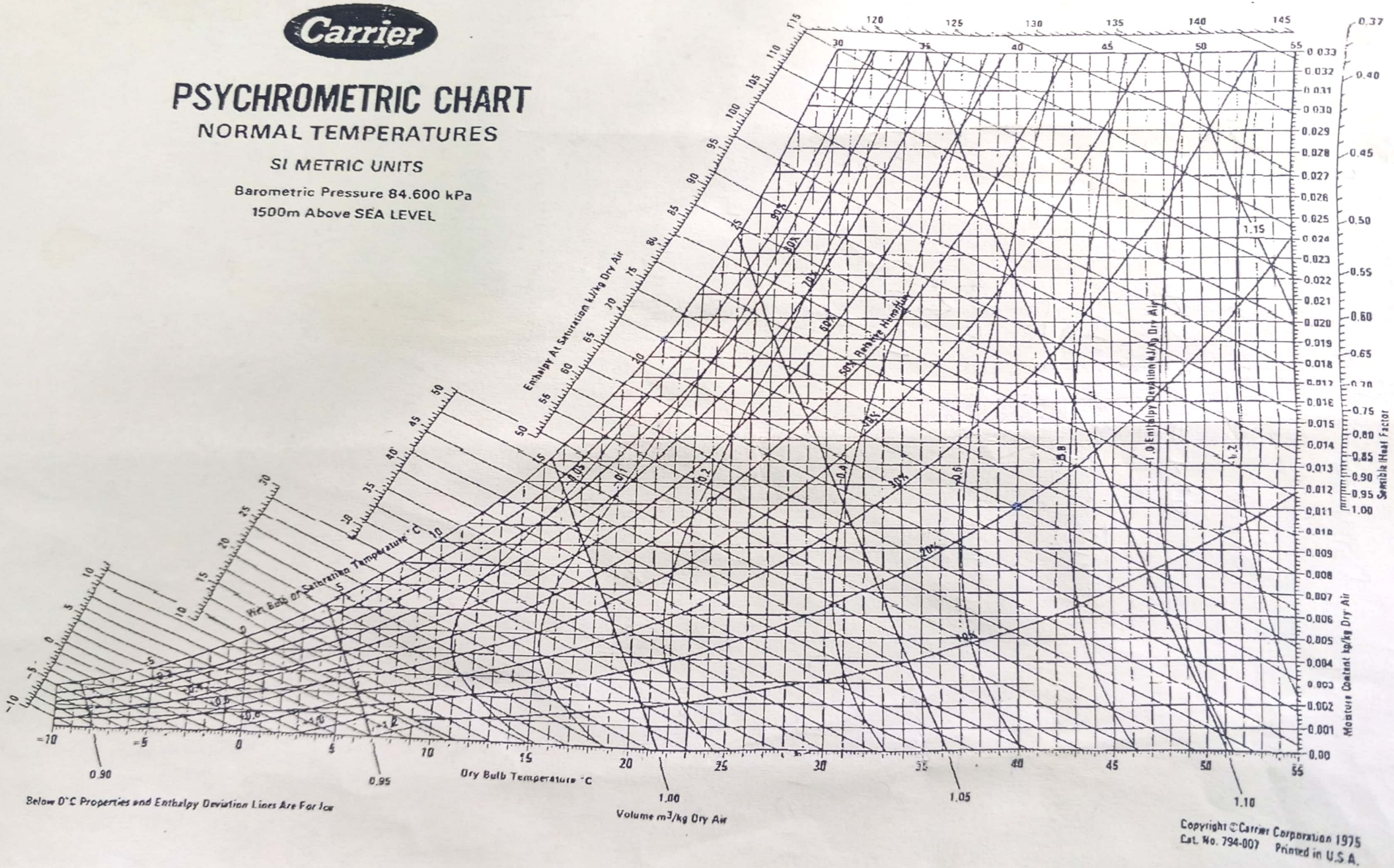

Carrier
PSYCHROMETRIC CHART
NORMAL TEMPERATURES
SI METRIC UNITS
Barometric Pressure 84.600 kPa
1500m Above SEA LEVEL
Enthalpy At Saturation kJ/kg Dry Air
Wet Bulb Or Saturation Temperature °C
Dry Bulb Temperature °C
Volume m3/kg Dry Air
Moisture Content kg/kg Dry Air
Sensible Heat Factor
50% Relative Humidity
Below 0°C Properties and Enthalpy Deviation Lines Are For Ice
0.90
0.95
1.00
1.05
1.10
1.15
Copyright © Carrier Corporation 1975
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Fig. Q4

THE UNIVERSITY OF ZAMBIA

SCHOOL OF ENGINEERING

DEPARTMENT OF AGRICULTURAL ENGINEERING

FARM STRUCTURES (AEN 4131) – TEST TWO

TIME: TWO (2) HOURS

INSTRUCTIONS:

ANSWER ALL QUESTIONS

INFORMATION

1. THIS EXAMINATION PAPER CONTAINS FOUR (4) QUESTIONS
2. ALL QUESTIONS CARRY 25 MARKS
3. THE MARKS FOR EACH QUESTION ARE GIVEN IN BRACKETS

QUESTION 1

a) Give any TWO reasons why controlling the environment within farm buildings is important. [4]

b) Write short notes on the following air-water vapour mixture processes:

i) Sensible heating [3]
ii) Sensible cooling [3]
iii) Evaporative cooling [3]

c) At an air temperature of 30°C, a farm building contains 17 grams of water vapour per kilogram of dry air. Use the psychrometric chart for 1500 m above sea level to determine:

i) The relative humidity [2]
ii) The specific volume [2]
iii) The heat content of the air [2]
iv) How much water will be added to the air if an evaporative cooler reduces the temperature adiabatically (no heat loss or gain) to the lowest possible temperature? [3]
v) The temperature at which water vapour will start condensing if the air is cooled without any change in water content. [3]

QUESTION 2

a) List four (4) aims of ventilation in Agricultural buildings. [6]

b) A farmer in Chibombo has 360 pigs housed in one of his pig buildings. The piggery is naturally ventilated. The pigs have average weight of 62 kg per pig with a sensible heat output of 98 W per pig and moisture production of 112 g/hour per pig.

Details of the pig building are as follows:

Element	Area (m^2)	U value ($W/m^2.^oC$)
Roof	306	1.0
Floors	300	0.5
Walls	170	0.8

Given that, the specific heat of air C_p is 1.005 kJ/kg.°C with density of 1.2 kg/m^3. Use the psychometric chart for 1, 500 m above sea level conditions.

i. For ventilation rate of 0.2 m^3/hr.kg.pig, calculate the temperature inside the house when the outside temperature and relative humidity are 0°C and 60%.

[10]

ii. What is the relative humidity inside the house (use the initial conditions)?

[9]

QUESTION 3

a) ~~Briefly~~ discuss any FIVE environmental requirements of pig housing. **[10]**

b) A famer wishes to start a pig production unit with an initial investment of 50 sows. Using a single-stage growing and finishing management system, determine the number of farrowing, dry sow and growing/finishing pens for the pig production unit. Assume that 8 pigs per litter will survive to 12 weeks of age and the farmer plans to have two farrowings in a year. Use the following management parameters.

[15]

Farrowing interval:

Average weaning to conception interval	20 days
Gestation period	114 days
Suckling period (7 x 8 weeks)	56 days
Farrowing interval	**190 days**

Farrowing pens:

Period before farrowing	7 days
Suckling period	56 days
Rearing of weaners	28 days
Cleaning and sanitation of pens	7 days
Occupation per cycle	**98 days**

Servicing/gestation pens

Average weaning to conception interval	20 days
Gestation period less 7 days in farrowing pen	107 days
Cleaning and sanitation of pen	7 days
Occupancy per cycle	**134 days**

Growing/finishing accommodation:

One stage finishing:	

2015/16 ACADEMIC YEAR MID-YEAR FINAL EXAMINATIONS

MAY, 2016

AEN 4131 – FARM STRUCTURES

TIME: THREE (3) HOURS

INSTRUCTIONS:

ANSWER: FIVE QUESTIONS

INFORMATION:

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

QUESTION 1

(a) List the **five (5)** factors that influence the selection of building material in construction. **(5)**

(b) Discuss briefly the advantages and disadvantages of soil as a construction material. **(6)**

(c) Discuss the three (3) main methods of timber preservation. **(9)**

QUESTION 2

(a) Briefly discuss the placing and compaction of fresh concrete when constructing a building. **(7)**

(a) A farmer is building a concrete slab 25m long, 10m wide and 0.1m thick. The farmer has already built the foundation walls and backfilled the foundation. You are tasked to approximate the cost of building the slab. The slab should have a nominal mix of 1:2:4.

Calculate the total cost of building the concrete slab assuming it has no reinforcement. The concrete should have the water to cement ratio of 0.75.

You are informed of the following unit costs for the necessary materials and labour. Stones cost K100/tonne, Sand costs K75/tonne,

Cement costs K54/50kg (37L) bag, Labour costs are charged per m^3 of slab completed as K1,500/5m^3 of concrete and water is bought at a cost of K10/210L drum. (13)

Properties of the aggregate you intend to buy are as follows:

- Moisture content of sand: 2.5%,
- Moisture content of stones: 1.5%,
- Bulk density of the sand: 1400 kg/m^3,
- Bulk density of the stones: 1600 kg/m^3.

Taking decrease in volume to be 29% and wastage to be 6%

QUESTION 3

For the simply supported beam shown in Figure 3:

(a) Determine the reactions at the supports (4)

(b) Draw the shear force and bending moment diagrams for the beam. (12)

(c) Clearly mark the position of the maximum bending moment and determine its value. (4)

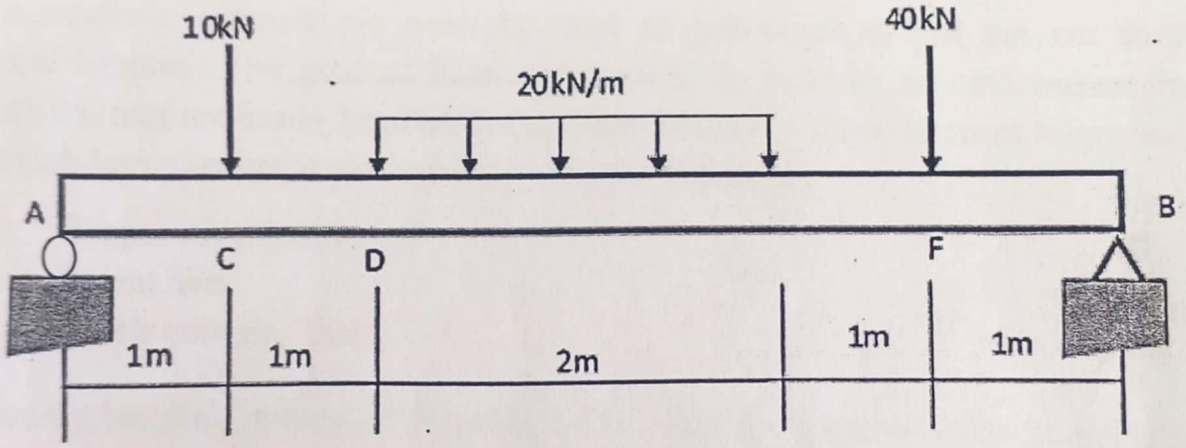


Figure 3

QUESTION 4

(a) List **four (4)** aims of ventilation in agricultural buildings. (4)

(b) A 25 m long, 12 m wide pig building has a 2.4 m side wall and a 4 in 12 slope of the roof. This naturally ventilated structure has a 0.1 m eave opening along each side, a 0.1 m ridge opening and no ceiling. Determine the velocity air flow rate for this structure, if the outside temperature is 18°C, the inside temperature is 29°C, the wind speed 4 m/s and the difference between inlet and outlet is 2 m. E = 0.35, θ = 0.63 due to:

i. Wind forces (3)

ii. Thermal forces (3)

iii. Due to combined forces (4)

(c) A farmer in Chibombo has 400 pigs housed in one of his pig buildings. The piggery is naturally ventilated. The pigs have average weight of 68 kg per pig with a sensible heat output of 170 W per pig and moisture production of 118 g/hour per pig.

Details of the pig building are as follows:

Element	Area (m^2)	U value ($W/m^2.°C$)
Roof	306	1.0
Floors	300	0.5
Walls	170	0.8

Given that, the specific heat of air C_p is 1.005 kJ/kg.°C with density of 1.2 kg/m^3. Use the psychometric chart for 1, 500 m above sea level conditions.

i. For ventilation rate of 0.2 m^3/hr.kg.pig, calculate the temperature inside the house when the outside temperature and relative humidity are 0°C and 60%. (3)

ii. What is the relative humidity inside the house (use the initial conditions)? (3)

QUESTION 5

(a) In agriculture, animals are normally kept in environments that are not their natural habitats. The goal of farm structures is to produce an environment in which animals are easily handled, fed and can produce without stress or injury and in which loss of crops is minimized. Define the following:

i. Evaporative cooling (2)
ii. Latent heat (2)
iii. Psychrometric Chart (2)

(b) A poultry building houses 2000 broilers. The sensible heat production at ambient temperature is approximately 8.4 W/bird and the moisture production is 6 g/hour per bird. The building has an average AU value of 0.34 kW/K. The outside temperature is 15 °C at a relative humidity of 70%, while the desired internal conditions must be maintained at a temperature of 25°C and a relative humidity of 75%. Six 100 W light bulbs are on in the building all the time for lighting. The latent of water vaporization is 2, 454 kJ/kg, while the specific heat capacity of air is 1.005 kJ/kg°C.

Find:

(i) Total heat gain in the building assuming that all moisture produced by the birds can evaporate. (4)

(ii) The minimum ventilation rate required to maintain the desired temperature. (5)

(iii) The minimum ventilation rate required to maintain the desired relative humidity. (5)

QUESTION 6

(a) Briefly discuss any **five (5)** environmental requirements of pig housing. **(5)**

(b) A farmer is running a pig unit with 50 sows. The farmer practices the following in rearing his pigs:

- It takes an average of 20 days from weaning to the day when a sow is successfully mated.
- Gestation period is 114 days
- The gestating sow is taken to the farrowing pen 7 days before farrowing.
- After farrowing, piglets are weaned at 8 weeks (suckling period) but remain in the pen till they are 12 weeks.
- On average, 10 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 farm's other pens is such that a pen can house 8 gestating sows or 10 growing/ fattening pigs.
- Each pen is cleaned and sanitized for 7 days

Determine the following:

i. The farrowing interval **(3)**

ii. The number of farrowing pens the farmer is expected to have. **(4)**

iii. The number of dry sow/gestating sow pens. **(4)**

iv. The number of growing/fattening pens **(4)**

************************END OF EXAMINATION***********************

LIST OF EQUATIONS

- $Q = EAV$
- $Q = VA;$
- $V = \varphi\,[(2gh\,(T_i - T_o/T_i)]^{1/2}$
- $q_s + q_e + q_{sup} \pm q_l - q_B = q_{vi} - q_{vo}$
- $q_v = q_s + q_{sup} - q_w - q_b$
- $q_v = q_s - q_b$
- $q_l = MNh_{fg}$
- $mC_p\Delta T = q_s - \sum AU\Delta T$
- $MN + mW_o = mW_i$
- $m(h_i - h_{tp}) = q_i$
- $q_v = mCp\Delta T$
- $q_B = \sum AU\Delta T$

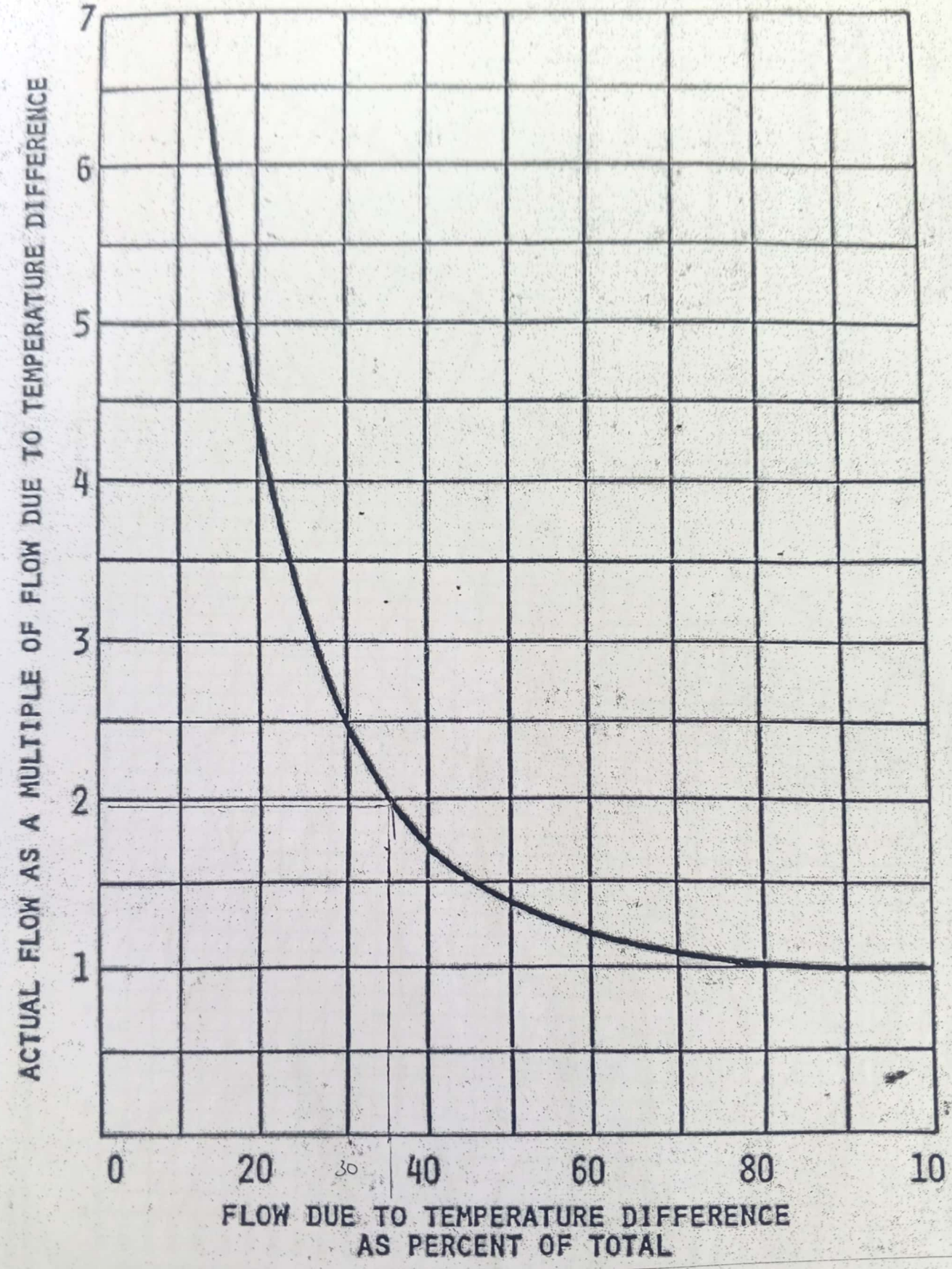


Figure 5: Determination of flow caused by combined forces of wind and temperature

THE UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
2017 ACADEMIC YEAR FIRST TERM TEST

APRIL, 2017

AEN 4131 – FARM STRUCTURES

TIME: TWO (2) HOURS

INSTRUCTIONS:

ANSWER: ALL QUESTIONS

INFORMATION:
1. ALL QUESTIONS CARRY **25 MARKS**
2. THE MARKS FOR EACH QUESTION ARE GIVEN IN BRACKETS

QUESTION 1

(a) List the **four (4)** functions of ventilations in buildings (6)

(b) Write short notes on the following air-water vapour mixture processes:

i) Sensible heating (3)
ii) Sensible cooling (3)
iii) Evaporative cooling (3)

(c) Building planning is concerned with providing the required standard facility at the lowest cost. Briefly discuss the planning stages involved in building projects. (10)

QUESTION 2

(a) A naturally ventilated pig building is 30m long, 12m wide and has a 2.4m high side-wall. The building has 120mm eaves opening along one side and an 80mm wide ridge opening and no ceiling. The difference in height between inlet and outlet is 2m. The outside temperature is 15°C and the inside temperature is 27°C. Consider E = 0.35 and θ = 0.65. The wind speed is 5.2m/s. Use Figures 2a and 2b to determine:

(i) the ventilation air flow rate due to wind. (3)
(ii) the ventilation air flow rate due to thermal effects. (4)
(iii) the ventilation air flow rate due to combined effects. (4)

(b) A poultry house contains 1500 broilers with an average weight of 1.5kg. The sensible heat production at ambient temperature is approximately 8.1W/bird while the moisture production is 6.2g/hour per bird. The building has an average AU value of 0.34 kW/K. The outside temperature is 18°C at 70% RH, while the desired internal conditions must be maintained at a temperature of 24°C and 75% RH. Four 100W light bulbs are on in the building all the time for lighting. The latent heat of water vaporisation is 2454 kJ/kg. Find:

(i) the total heat gain in the building assuming that all moisture produced by the birds can evaporate. (5)
(ii) the minimum ventilation rate required to maintain the desired temperature. (5)
(iii) the minimum ventilation rate required to maintain the desired relative humidity. (4)

QUESTION 3

(a) Briefly discuss the following environmental requirements for poultry:

(i) Temperature; (2.5)
(ii) Light; (2.5)
(iii) Ventilation; and (2.5)
(iv) Relative humidity. (2.5)

(b) A pig production unit has 40 sows in which the average suckling period is 8 weeks. Piglets remain in the farrowing pens for 4 weeks after weaning and 1 week is required for cleaning and sanitation before farrowing. The average weaning to conception period is 20 days, while the gestation period is 114 days. The sows are moved to the farrowing pens 1 week before farrowing, but 7 days must be added for cleaning the servicing/gestation pens.

Two stage growing and finishing is practised with growing pigs remaining in the growing pen from 12 to 20 weeks of age and in the finishing pen from 20 to 27 weeks of age. One week is required in the growing pen for cleaning and sanitation. Two weeks are required for selling off the finished pigs and 1 week for cleaning the finishing pen. Assume that 9 piglets survive to finishing. Determine:

(i) The number of farrowing's per year. (3)
(ii) the number of farrowing pens. (3)
(iii) the number of servicing/gestation pens each housing 4 sows. (3)

(iv) the number of growing pens with 10 pigs each. (3)

(v) the number of finishing pens with 8 pigs each. (3)

QUESTION 4

(a) List the key requirements to consider when selecting a site for chicken housing. (6)

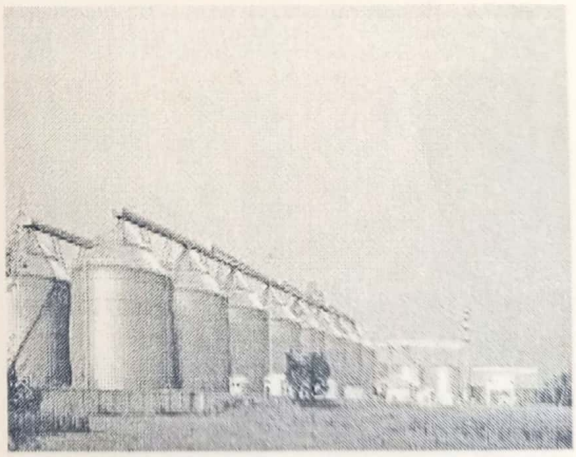
(b) Briefly discuss the role of storage in the economy. (5)

(c) The two (2) alternative large-scale grain storage technologies used in Zambia are given in Table 4. Typical designs of the infrastructure are shown in Figures 4(a) and 4(b). Most large-scale grain stores in Zambia have been designed for bag storage, but a few bulk storage structures also exist especially in cities and among grain milling companies. Make a comparison of the two (2) alternative systems. (7)

Table 4: Large-scale grain storage technologies

Bag system	Warehouses; Permanent platforms covered by tarpaulins
Bulk system	Concrete silos; Steel silos

(a) Bag storage in a warehouse



(b) Bulk storage in steel silos

(d) Briefly discuss the factors to consider when locating a warehouse (7)

SOME USEFUL EQUATIONS

$Q = AU\Delta T$ $\quad Q = EAV$ $\quad V = \theta(2gh(T_i - T_o)/T_i)^{1/2}$ $\quad q_v = m(h_{tp} - h_o)$

$q_v = mC_p\,\Delta T$ $\quad q_b = \Sigma AU\Delta T$ $\quad q_l = MNh_{fg}$

$$m = \frac{MN}{W_i - W_o} \qquad m = \frac{q_l}{h_i - h_{tp}}$$

2017 ACADEMIC YEAR FIRST TERM TEST

FEBRUARY, 2017

AEN 4131 – FARM STRUCTURES

TIME: TWO (2) HOURS

INSTRUCTIONS:

ANSWER: ALL QUESTIONS

INFORMATION:
1. ALL QUESTIONS CARRY **25 MARKS**
2. THE MARKS FOR EACH QUESTION ARE GIVEN IN BRACKETS

QUESTION 1

(a) List the **five (5)** factors that influence the selection of building material in construction. (5)

(b) Discuss briefly the advantages and disadvantages of soil as a construction material. (6)

(c) List the **five (5)** attributes that an effective preservative should possess (5)

(d) Discuss the **three (3)** main methods of timber preservation. (9)

QUESTION 2

(a) Concrete mixing can be performed in two (2) ways either using on-site mixing and ready-mixed concrete from a batching plant. Write short notes explaining both methods of mixing and outline the advantages and disadvantages of each method. **(10)**

(b) List at least **five (5)** methods of transporting and placing concrete. **(5)**

(c) Calculate the **number of bags of cement**, **tonnes of sand** and **tonnes of stone** required to construct a concrete floor of a building. The floor is 9.2m long, 5.3m wide and 100mm deep. Assume a decrease of 30% due to mixing and a further 5% due to wastage.

If the water-cement ratio by weight is 0.62, calculate the **volume of water required** for mixing and determine the **maximum size of aggregate** to be used. Use a mix of **1:3:5** by volume. **(10)**

The properties of the materials are as follows:
Bulk density of cement: 3160 kg/m³
Bulk density of sand: 1400 kg/m³ at 3.2% moisture content
Bulk density of stones: 1600 kg/m³ at 1.3% moisture content
Density of water: 1000 kg/m³

QUESTION 3

(a) List **three (3)** functions of each of the following building elements. **(12)**

i. Foundations
ii. Walls
iii. Floors
iv. Roofs

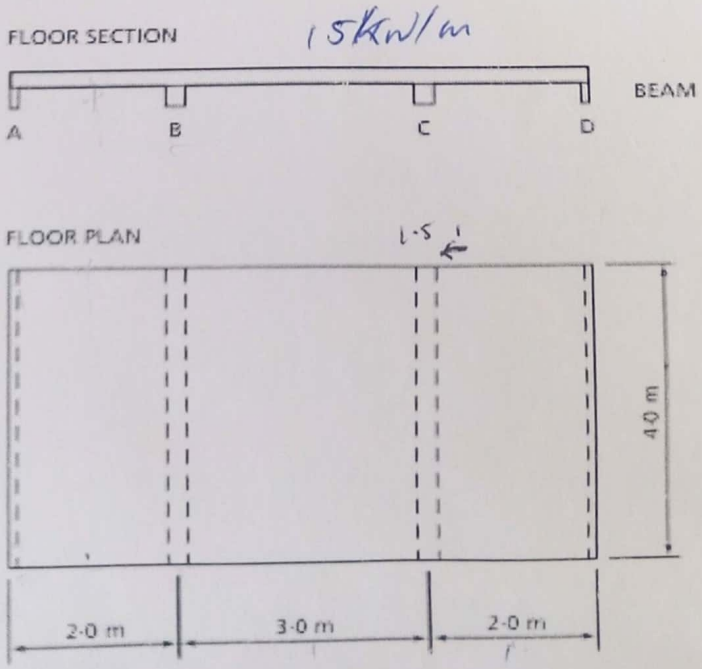
(b) Write short notes on laying of galvanised corrugated steel roofing sheets **(7)**

(c) Consider a suspended floor where the loads are supported by a set of irregularly placed beams. Let the load arising from the weight of the floor itself and the weight of any material placed on top of it be 15 kN/m².

Determine:

i. The total load supported by beams A and C. **(3)**

ii. The uniformly distributed load acting on beam A and beam C. **(3)**



QUESTION 4

For the simply supported beam shown in Figure Q4:

(a) Determine the reactions at the supports **(4)**

(b) Draw the shear force and bending moment diagrams for the beam. **(15)**

(c) Clearly mark the position of the maximum bending moment and determine its value. **(6)**

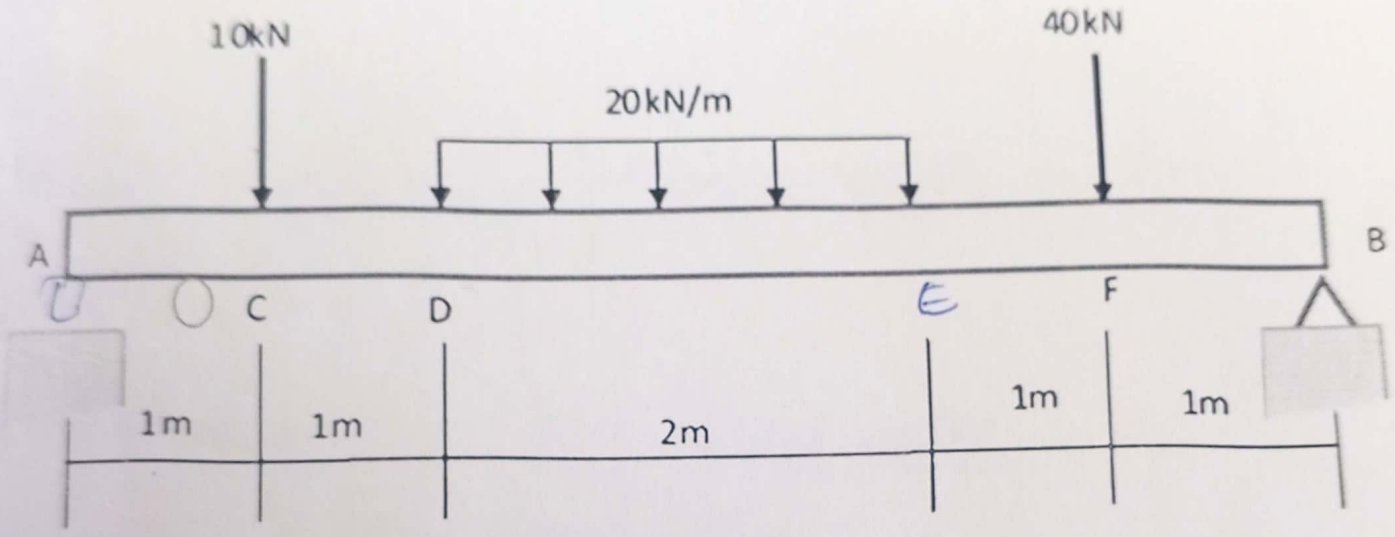


Figure Q4

Q3 (a) (iv) Roofs function

- protection against weather conditions such as
- rain, cold, sun, wind

(b) Laying of galvanised corrugated steel roofing sheed

- It is started from bottom going up roof.
- there must be an overlap between sheets
- When laying the sheets studying of ~~wind~~ wind direction is vital
- The nail should be hammered on top of a ridge of sheet.
- The roof should have a slip slope to allow easy falling of water.

(c) (i) total load supported by beam:

Beam A = $1m \times 4m = 4m^2$ => Area ∴ $4m^2 \times 15kN/m^2 = 60kN$

total load = $1m \times 15kN/m^2 = 15kN$

Beam C = $2.5m \times 4m = 10m^2$ => Area ∴ $10m^2 \times 15kN/m^2 = 150kN$

total load = $2.5m \times 15kN/m^2 = 34.5kN$

(ii) the uniformly distributed load ~~act~~ on A & C

Beam A = ~~15kN x 4m~~ $15kN \times 4m = \frac{60kN}{4} = 15kN$

Beam C = ~~34.5~~ $34.5 \times 4m = 138kN$ $\frac{150}{4} = 37.5kN$

Q4. $\Sigma f_y = 0$

$\Sigma M_o = 0$

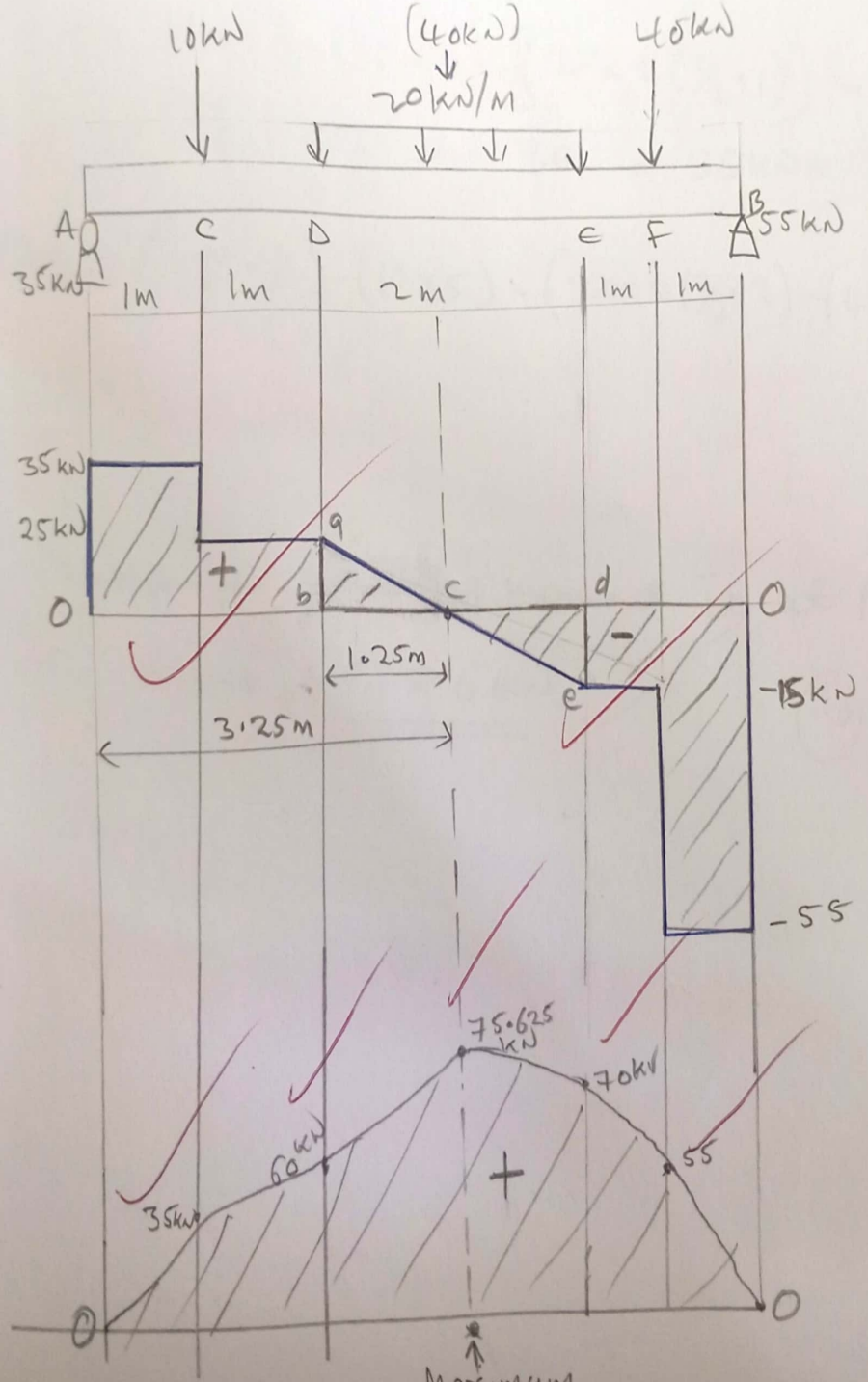
$R_A + R_B = 10kN \times (20kN/m \times 2) + 40kN = 90kN$

$R_B \times 6m = 0 + (10 \times 1) + [20 \times 2 (\frac{3}{2}+1)] + (40 \times 5)$

$R_B \times 6m = 10 + 120 + 200 = 330 kN \cdot m$

$R_B = \frac{330}{6} = 55kN$

$\therefore R_A = 90 - 55 = 35kN$



$\frac{ab}{de} = \frac{bc}{2-bc}$

$\frac{25}{15} = \frac{bc}{2-bc}$

$50 - 25bc = 15bc$

$bc = \frac{50}{40} = 1.25m$

Q4

$\Sigma M_A = 0$

$\Sigma M_C = (35 \times 1) = 35 kN.M$

$\Sigma M_D = (35 \times 2m) - (10 \times 1m) = 60 kN.M$

$\Sigma M_E = (35 \times 4m) - (10 \times 3m) - [20 \times 2(\frac{2}{2}) =$

$140 - 30 - 40 = 70 kNM$

$\Sigma M_{max} (35 \times 3.25) - (10 \times 2.25) - [20 \times 1.25(\frac{1.25}{2}) =$

$113.75 - 22.5 - 15.625 = 75.625 kNM$

$\Sigma M_f = (35 \times 5) - (10 \times 4) - [20 \times 2(\frac{3}{2}+1)] =$

$175 - 40 - 80 = 55 kNM$

$\Sigma M_B = (35 \times 6) - (10 \times 5) - (20 \times 2(\frac{3}{2}+2) - (40 \times 1) = 0$

c) Maximum bending moment is at point A and the value is 75.6 kN

(10)

UNIVERSITY OF ZAMBIA
SCHOOL OF ENGINEERING
DEPARTMENT OF AGRICULTURA ENGINEERING

AEN 4131 FARM STRUCTURES

10

ASSIGNMENT 2

DUE: 28 FEBRUARY, 2017

QUESTION 1

For the simply supported beam shown in Figure 1:

(a) Determine the reactions at the supports
(b) Draw the shear force and bending moment diagrams for the beam.
(c) Clearly mark the position of the maximum bending moment and determine its value.

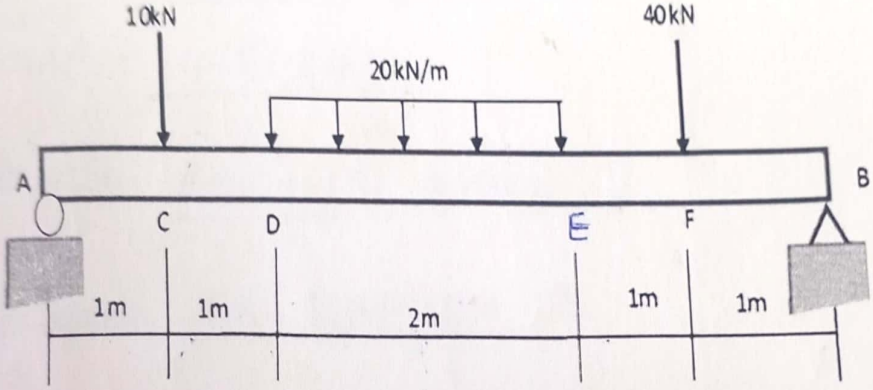
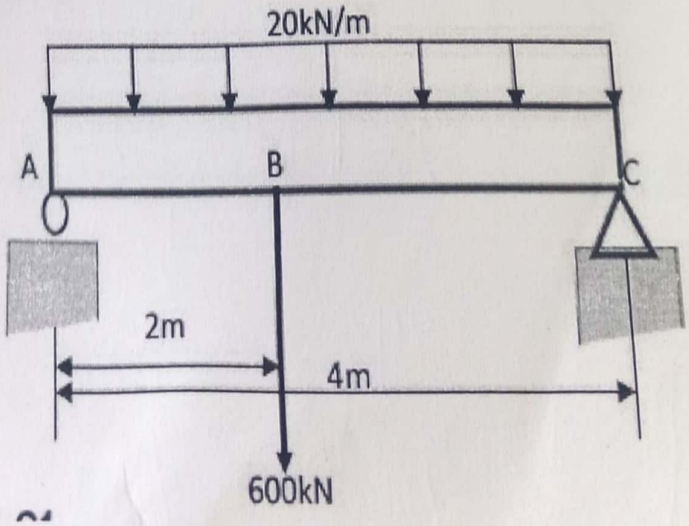


Figure 1

QUESTION 2

Fig. Q1 shows how one bean of a suspended storage floor was loaded at a particular time of a day. The unifo distributed load of the weight of the farm produce and the floor itself was 20kN/m. The owner of the structure using the beam to hoist a 600kN load into a Light truck.

(a) Determine the reactions at A and C
(b) Draw the shear force and bending moment diagrams for the beam
(c) State the location and the maximum absolute values of the shear force and the bending moment.



THE UNIVERSITY OF ZAMBIA
SCHOOL OF AGRIC. SCIENCES
DEPARTMENT OF AGRIC. ENGINEERING

NAME: AUSTEN SHAKWANDA

COMP: 14151243

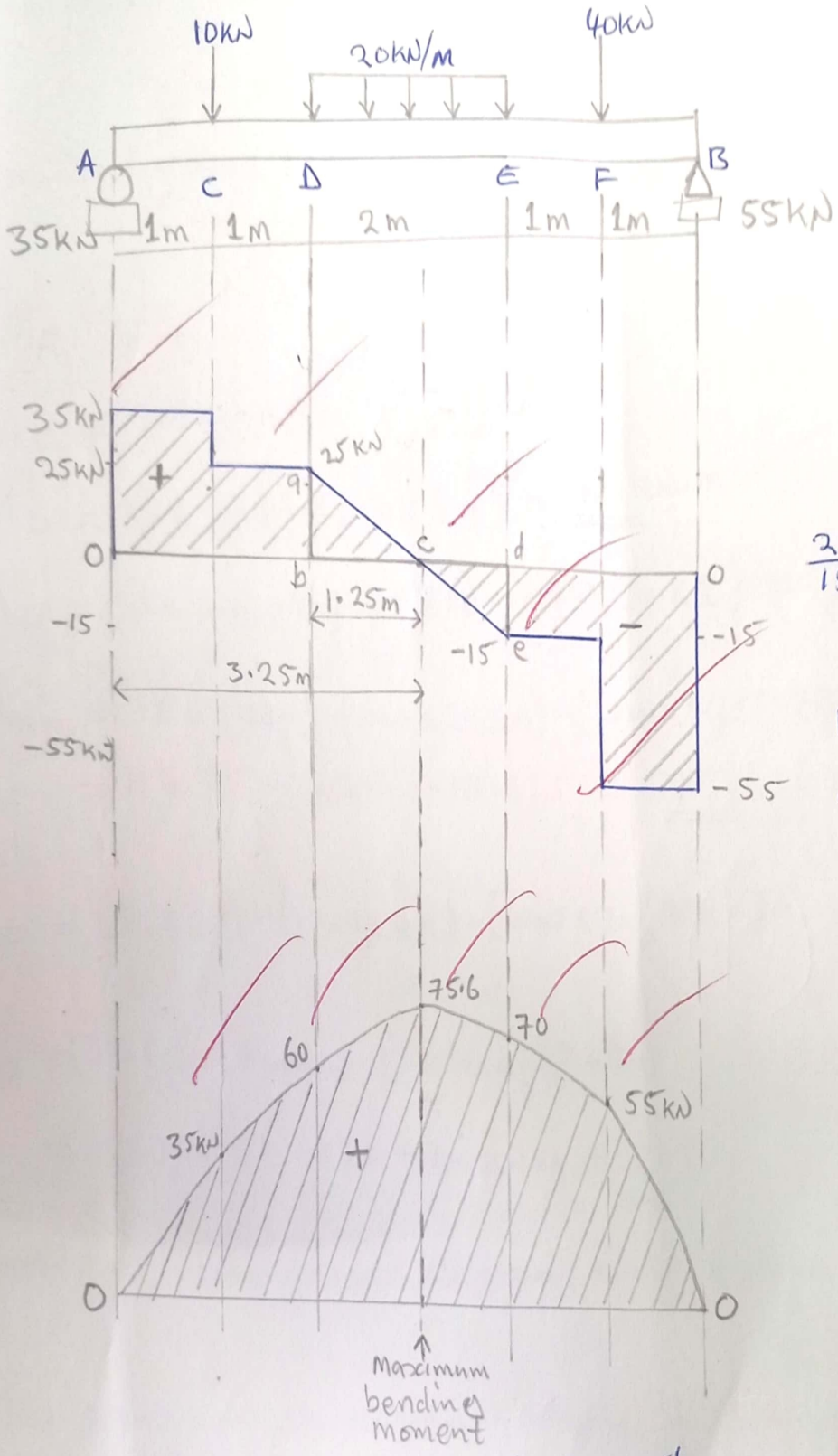
COURSE: AEN 4131 ASSIGN. 2

LECTURER: MR. KAPULU M.

DUE DATE: 28-02-17

18

1. for the Simply supported beam shown



$$\frac{ab}{de} = \frac{bc}{cd}$$

$$\frac{25}{15} = \frac{bc}{2-bc}$$

$$15bc = 50 - 25bc$$

$$15bc + 25bc = 50$$

$$40bc = 50$$

$$bc = \frac{50}{40} = 1.25m$$

) Determine the reactions at the supports

$\Sigma f_y = 0$, $\Sigma M_o = 0$

$$R_A + R_B = 10KN + (20KN/m \times 2m) + 40KN = 90KN$$

$$R_B \times 6m = 0 + (10KN \times 1m) + [20\frac{KN}{m} \times 2m\ (3m/2 + 2m)] + (40KN \times 5)$$

$$R_B = \frac{10KN.m + 120KN.m + 200KN.m}{6m} = \frac{330\ KN.m}{6m} = 55KN$$

$R_A + R_B = 90kN$

$\therefore R_A = 90kN - 55kN = 35kN$

(b) Draw the shear force and bend moment diagrams for the beam.

$\Sigma M_A = \underline{0}$

$\Sigma M_C = 35kN \times 1m = \underline{35kN.m}$

$\Sigma M_D = (35 \times 2m) - (10kN \times 1m) = \underline{60kN.m}$

$\Sigma M_E = (35 \times 4m) - (10kN \times 3m) - (20kN \times 2m \times 1) = \underline{70kN.m}$

$\Sigma M_{max} = (35 \times 3.25m) - (10kN \times 2.25m) - [20kN \times 1.25(1.25/2)]$

$= 113.75 - 22.5 - 15.625 = \underline{75.625\ kN.m}$

$\Sigma M_F = (35 \times 5m) - (10kN \times 4m) - [20kN \times 2m(\frac{2m}{2} + 1m)] = 175 - 40 - 80 = S$

$\Sigma M_B = (35 \times 6m) - (10kN \times 5m) - [20kN \times 2m(\frac{2m}{2} + 2m)] - (40kN \times 1m)$

$= 210 - 50 - 120 - 40kN.m = \underline{0\ kN.m}$

⇒ Shear and bending moment diagrams for the beam are shown above

(c) The position of the maximum bending is clearly marked on the a shear and bending moment diagram and its value is 75

It is 3.25m from Point A to B.

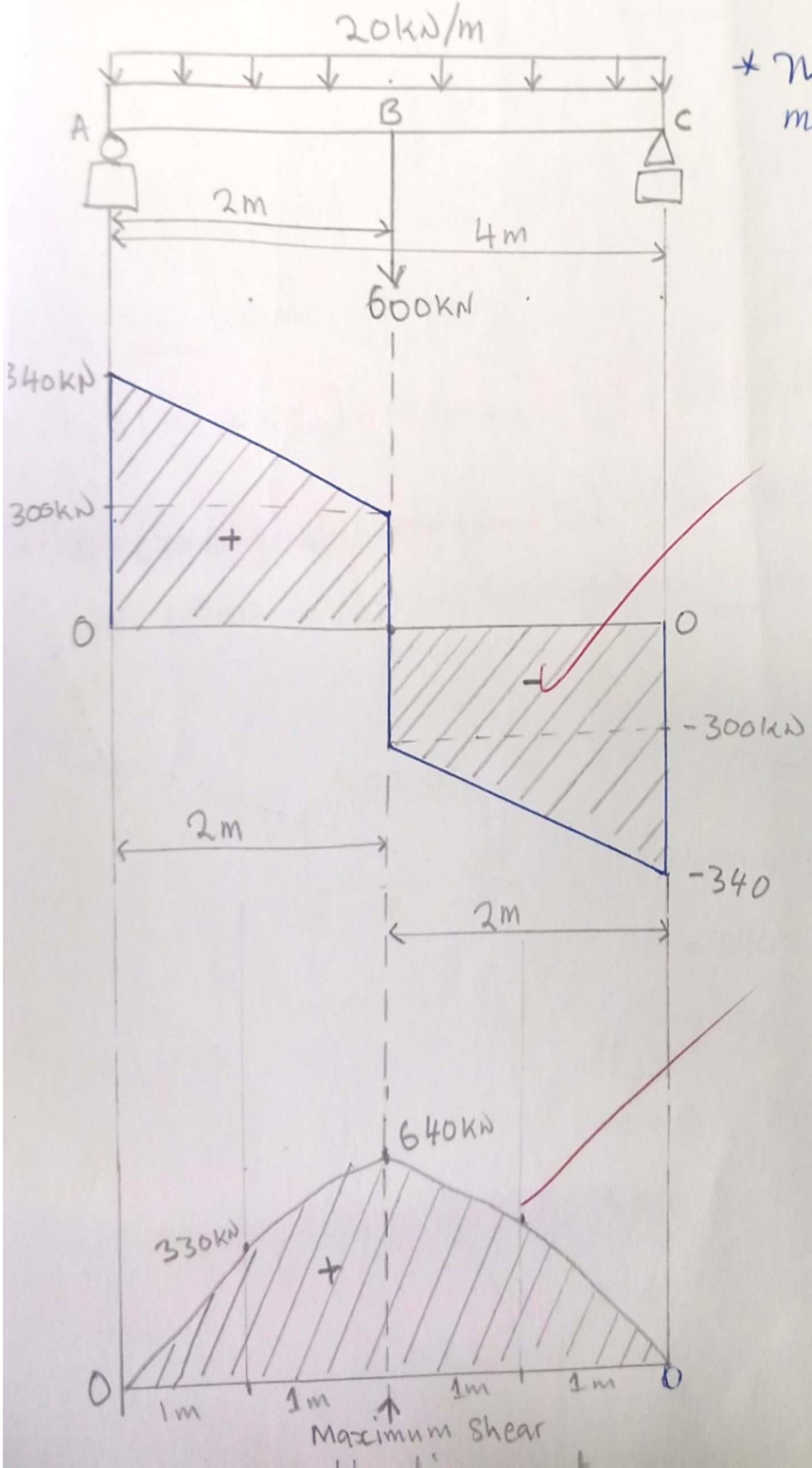
Q2. The uniformly distributed load of the weight of the farm produce and the floor itself was 20kN/m. The owner of the structure was using the beam to hoist a 600kN load into a light truck.

(a) Determine the reaction at A and C.

(b) Draw the shear force and bending moment diagrams for the beam.

(c) State the location and the maximum absolute values of the shear force and the bending moment. → The maximum shear force is located at point A which is 300kN

* The maximum bending moment is 640kN.



Solutions

(a) $\Sigma f_y = 0$

$\Sigma M_A = 0$

$R_A + R_C = 600kN + (20kN/m \times 4m) = 680kN$

$R_C \times 4m = 0 + (600kN \times 2m) + [20kN/m \times 4m (4/2)] = 1200 + 160 = 1360kN.m$

$\therefore R_C = \frac{1360kN.M}{4m} = 340kN$

$R_A + R_C = 680kN$

$R_A = 680kN - 340kN = 340kN$

3

(b)

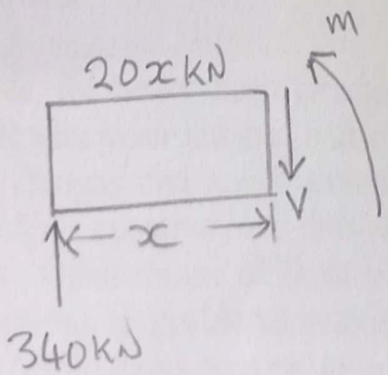
$\Sigma M_A = 0\ kN.m$

$\Sigma M_B = (340kN \times 2m) - (20kN \times 4 (4/2) = 680 - 160 = 520\ kN.m$

$\Sigma M_C = (340kN \times 4m) - (20kN \times 4m (4/2) - (600kN \times 2m)$

$= 1360 - 160 - 1200\ kN.m = 0\ kN.m$

$\Sigma M_{max} =$



$0 \leq x \leq 2m$

$340xkN - (20x \times \frac{x}{2}) - M = 0$

$M = 340x - \frac{20x^2}{2} = 340x - 10$

IF:

$x = 0$, $M = 0$

$x = 1$, $M = 330\ kN.m$

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UNZA - AGRIC

AEN 4131 – FARM STRUCTURES

ASSIGNMENT THREE

DUE DATE: DECEMBER 10, 2015

Question One

a) Fig. Q1 shows how a beam of a suspended storage floor was loaded at a particular time of a day. The uniformly distributed load of the weight of the farm produce and the floor itself was 20kN/m. The owner of the structure was using the beam to hoist a 450kN load into a right truck. The hoisted load acts mid-way through the beam.

i. Determine the reactions at A and C
ii. Draw the shear force and bending moment diagrams for the beam
iii. State the location and the maximum absolute values of the shear force and the bending moment.

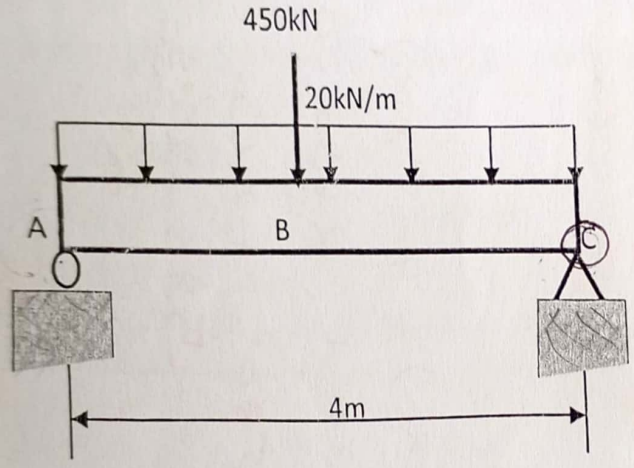
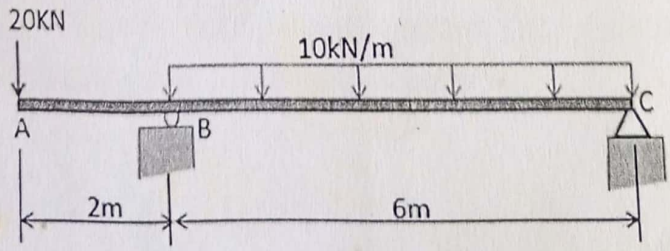


Fig. Q1

Question Two

A simply supported beam is loaded as shown in Fig. Q2.

a) Determine the reactions at the supports
b) Draw the shear force and bending moment diagrams for the beam.
c) State the maximum shear force and bending moment values and their location.



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