EGERTON UNIVERSITY

UNIVERSITY EXAMINATIONS

NJORO CAMPUS

SECOND SEMESTER 2011/2012

FOURTH YEAR EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN AGRICULTURAL ENGINEERING

AGEN 442: AGRICULTURAL STRUCTURES

STREAM: 2008 (Y4) AGEN **TIME:** 2 HOURS

DAY/TIME: TUESDAY, 12.00 – 02.00 PM **DATE:** 08/05/2012

INSTRUCTIONS:

1. The paper consists of **FOUR (4)** questions.
2. Attempt **QUESTION ONE** and any other **TWO (2)** questions.
3. Marks for each question are shown in parenthesis.
4. Useful information is provided in the appendices.
5. **EACH QUESTION SHOULD BE STARTED ON A NEW PAGE.**

QUESTION ONE (COMPULSORY)

(a) List the major steps followed in structural design. **(2.5 marks)**

(b) A floor to a grain storage facility has I-section steel joists simply supported at each end and carry a distributed load of grain over the whole span as illustrated in Figure Q1a. The loading distribution is represented by the equation $\omega = ax^2 + bx + c$ where ω is the load intensity in kN/m^2 at a distance x along the beam while a, b and c are constants. The load intensity is zero at each end and has a

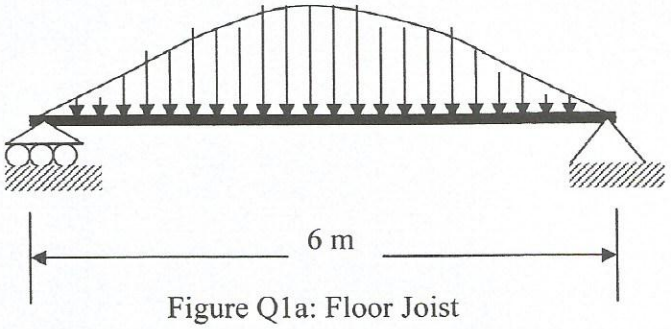

Figure Q1a: Floor Joist

maximum value of 4 kN/m^2 at mid-span.

(i) Sketch the bending moment diagrams form the joist

(ii) Determine the maximum bending moment for the joist

(iii) Determine width, depth, flange and web thickness for the appropriate I –section steel beam for the floor joist given the maxim stress in steel should not exceed 150 MN/m^2

(27.5 marks)

Useful information is provided in Appendix V: 3 and;

$$\frac{d(SF)}{dx} = -\omega \qquad \frac{d(BM)}{dx} = SF \qquad \frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$$

QUESTION TWO

(a) Give five types of structures you would expect to find in the agricultural sector in Kenya. Give an example of each structure. **(2.5 marks)**

(b) Figure Q2 shows a wooden truss for a zero grazing unit. Determine the size (from common timber sizes available in local timber yards) of timber to be used to construct the truss given that all the members of the truss are of the same cross-section. Allowable Compressive and tensile strength for wood is 6.0 N/ mm^2 and 1.2 N/ mm^2 respectively. **(17.5 marks)**

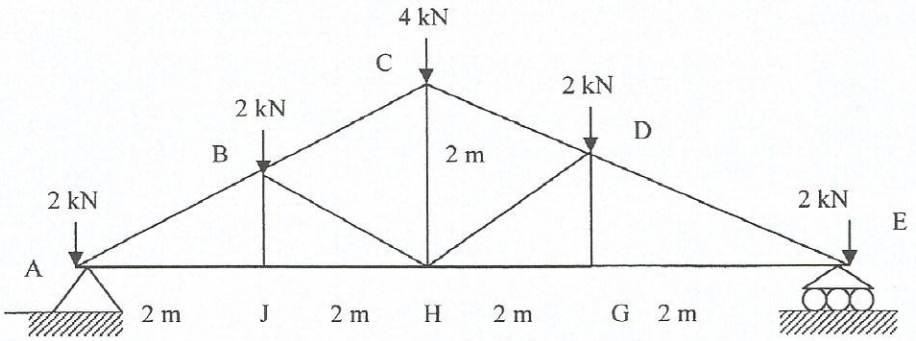

Figure Q2: Truss

QUESTION THREE

(a) What are the functions of ventilation in animal housing? **(2 marks)**

(b) A farmer wishes to use convert a gable-roofed garage into a layers house. This is to be achieved by maintaining the indoor temperature and relative humidity 20 °C d.b. and 70 % RH respectively using a solar air conditioning system. The garage measures 3 m wide, 6 m long, 2 m high at the wall plate and 3 m high at the ridge. It has 0.5 m^2 of window (glass) and 8 m^2 door (wood). The walls are made of brick and the roof is tiled.

(i) Determine the volume flow rate of air required to maintain the garage at the design temperature if the supply air is conditioned to a temperature of 16 °C d.b.

(ii) What is the humidity ratio of the supply air?

(iii) State the processes though which outdoor air must go through before being supplied to the poultry house.

Use the following information:

- Moisture and sensible heat production per bird at optimal conditions are 6.0 g/h and 7.6 W, respectively.
- Stocking density is 5 birds/m^2
- Density of air at 20 $^{\circ}$C is 1.2 kg/m^3
- Latent heat of vaporization of water at 20 $^{\circ}$C is 2453.7 kJ/kg
- U values in W/m^2-K for brick, roof tile, wood and glass are 2.04, 4.0, 2.4 and 6, respectively
- Ambient air is at temperature is 27 $^{\circ}$C and 60 % relative humidity.
- Neglect heat loss/gain into the garage through the floor.
- Specific heat capacity of air is 1.005 kJ/kg-K. **(18 marks)**

QUESTION FOUR

(a) List **six** requirements that must be satisfied by a new cattle housing facility. **(3 marks)**

(b) A full equipped cubicle dairy house with mechanical offloading of silage and a herringbone milking parlour is to be built for 120 cows. The labour management to be used is two shift per day each running for six hours. Determine the number of people to be hired to manage the new facility. Useful information in Appendix A. Make and state any assumptions. **(8 marks)**

(c) Figure Q4 shows the cross section of a slurry manure pit for the cubicle dairy unit in Q4b. the slurry manure is to be stored for 30 days and then transported to the filed. If the total slurry storage allowed is 0.065 m^3 per day per cow, determine the width and the non sloping length of the pit. **(9 marks)**

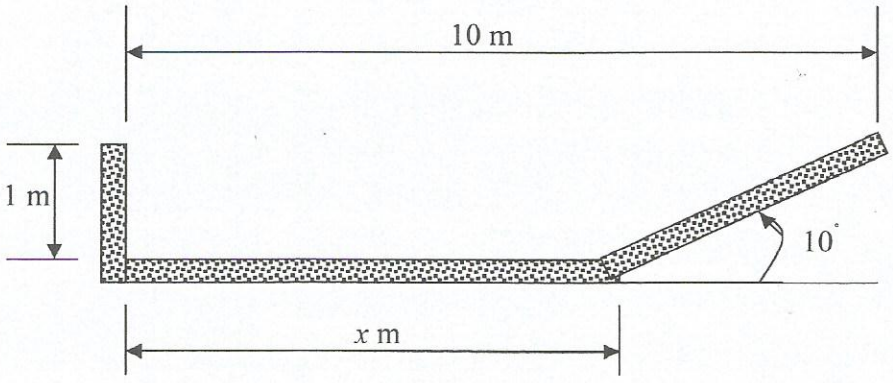

Figure Q4: Slurry Pit

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APPENDIX A

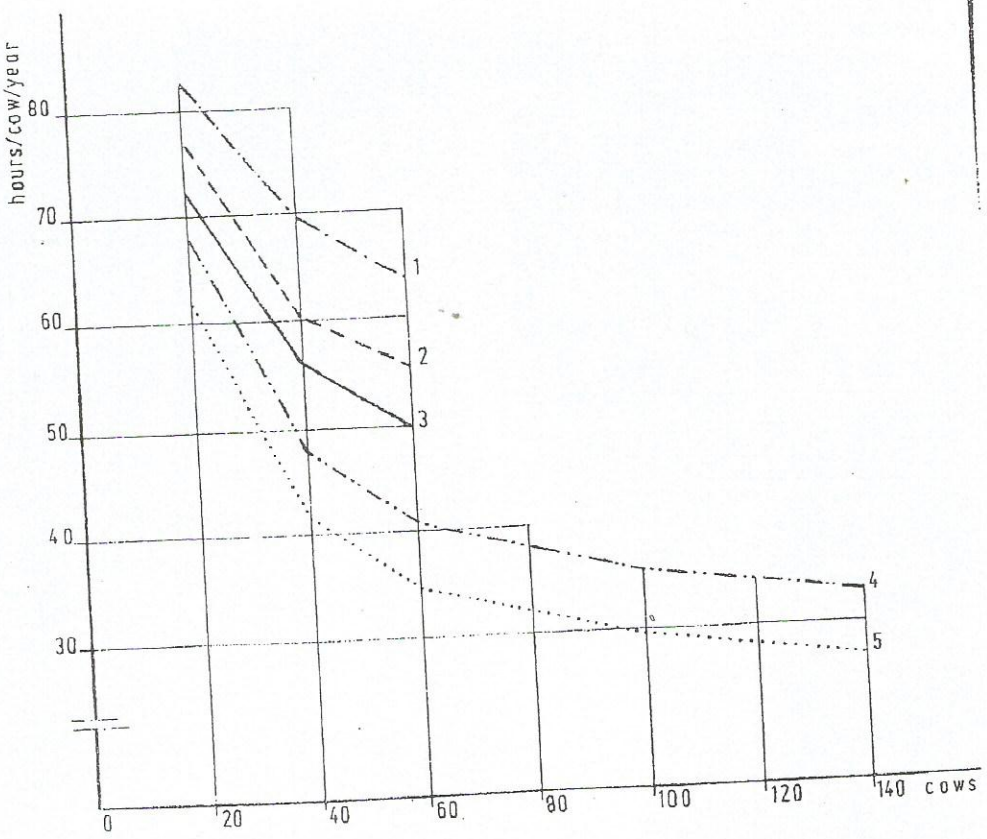
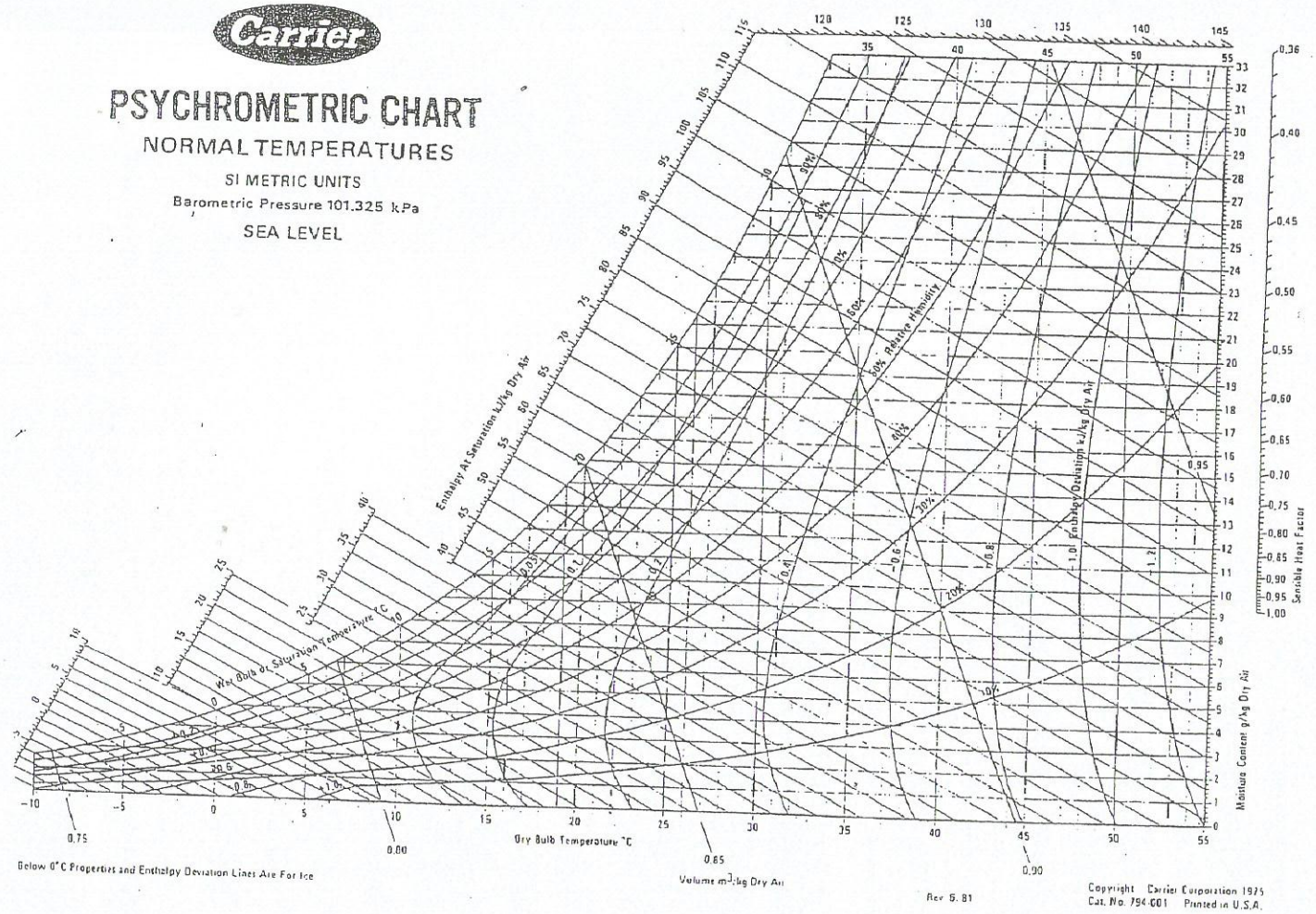


Fig. 1-A The labour requirement (expressed in hours/cow/year) in different types of dairy houses and according to their size.
Legend : 1 = littered stanchion barn, hand feeding, milking machine ; 2 = littered stanchion barn, mechanical feeding, pipeline milking installation ; 3 = stanchion barn with grids, hand feeding, pipeline milking installation ; 4 = cubicle house, mechanical unloading of silage, herringbone milking parlour ; 5 = cubicle house, mechanical unloading of silage, herringbone milking parlour and automatic cluster removal.


Carrier
PSYCHROMETRIC CHART
NORMAL TEMPERATURES
SI METRIC UNITS
Barometric Pressure 101.325 kPa
SEA LEVEL
Dry Bulb Temperature °C
Wet Bulb or Saturation Temperature °C
Enthalpy At Saturation kJ/kg Dry Air
Moisture Content g/kg Dry Air
Enthalpy Deviation kJ/kg Dry Air
Sensible Heat Factor
Volume m³/kg Dry Air
10% relative humidity
30%
50%
70%
90%
Below 0°C Properties and Enthalpy Deviation Lines Are For Ice
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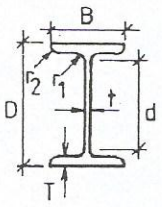
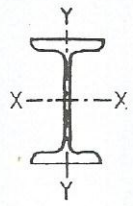
Appendix V



Appendix V: 3 *Dimensions and Properties of Steel I Beams*

Nominal size	Mass per metre	Depth of section D	Width of section B	Thickness		Radius		Depth between fillets d	Area of section
				Web t	Flange T	Root r1	Toe r2		
mm	kg	mm	mm	mm	mm	mm	mm	mm	cm²
254 × 203	81.85	254.0	203.2	10.2	19.9	19.6	9.7	166.0	104.4
254 × 114	37.20	254.0	114.3	7.6	12.8	12.4	6.1	199.2	47.4
203 × 152	52.09	203.2	152.4	8.9	16.5	15.5	7.6	133.2	66.4
203 × 102	25.33	203.2	101.6	5.8	10.4	9.4	3.2	161.0	32.3
178 × 102	21.54	177.8	101.6	5.3	9.0	9.4	3.2	138.2	27.4
152 × 127	37.20	152.4	127.0	10.4	13.2	13.5	6.6	94.3	47.5
152 × 89	17.09	152.4	88.9	4.9	8.3	7.9	2.4	117.7	21.8
152 × 76	17.86	152.4	76.2	5.8	9.6	9.4	4.6	111.9	22.8
127 × 114	29.76	127.0	114.3	10.2	11.5	9.9	4.8	79.4	37.3
127 × 114	26.79	127.0	114.3	7.4	11.4	9.9	5.0	79.5	34.1
127 × 76	16.37	127.0	76.2	5.6	9.6	9.4	4.6	86.5	21.0
127 × 76	13.36	127.0	76.2	4.5	7.6	7.9	2.4	94.2	17.0
114 × 114	26.79	114.3	114.3	9.5	10.7	14.2	3.2	60.8	34.4
102 × 102	23.07	101.6	101.6	9.5	10.3	11.1	3.2	55.1	29.4
102 × 64	9.65	101.6	63.5	4.1	6.6	6.9	2.4	73.2	12.3
102 × 44	7.44	101.6	44.4	4.3	6.1	6.9	3.3	74.7	9.5
89 × 89	19.35	88.9	88.9	9.5	9.9	11.1	3.2	44.1	24.9
76 × 76	14.67	76.2	80.0	8.9	8.4	9.4	4.6	38.0	19.1
76 × 76	12.65	76.2	76.2	5.1	8.4	9.4	4.6	37.9	16.3



Appendix V:3 *Continued: Joists, Dimension and Properties*

Niminal size	Moment of inertia			Radius of gyration		Elastic Modulus		Ratio
	Axis x-x		Axis	Axis	Axis	Axis	Axis	D
	Gross	Net	y-y	x-x	y-y	x-x	y-y	T
mm	cm^4	cm^4	cm^4	cm	cm	cm^3	cm^4	
254 × 203	12016	10527	2278	10.7	4.67	946.1	224.3	12.8
254 × 114	5092	4243	270.1	10.4	2.39	401.0	47.19	19.8
203 × 152	4789	4177	813.2	8.48	3.51	471.4	106.7	12.3
203 × 102	2294	2024	162.6	8.43	2.25	225.8	32.02	19.6
178 × 102	1519	1339	139.2	7.44	2.25	170.9	27.41	19.7
152 × 127	1818	1627	378.8	6.20	2.82	238.7	59.65	11.5
152 × 89	881.1	762.6	85.98	6.36	1.99	115.6	19.34	18.4
152 × 76	873.7	736.2	60.77	6.20	1.63	114.7	15.90	15.9
127 × 114	979.0	800.9	241.9	5.12	2.55	154.2	42.32	11.0
127 × 114	944.8	834.6	235.4	5.26	2.63	148.8	41.19	11.2
127 × 76	569.4	476.1	60.35	5.21	1.70	89.66	15.90	13.3
127 × 76	475.9	400.0	50.18	5.29	1.72	74.94	13.17	16.7
114 × 114	735.4	651.2	223.1	4.62	2.54	128.6	39.00	10.7
102 × 102	486.1	425.1	154.4	4.06	2.29	95.72	30.32	9.9
102 × 64	217.6	182.2	25.30	4.21	1.43	42.84	7.97	15.4
102 × 44	152.3	126.9	7.91	4.01	0.91	30.02	3.44	16.7
89 × 89	306.7	263.7	101.1	3.51	2.01	69.04	22.78	9.0
76 × 76	171.9	144.1	60.77	3.00	1.78	45.06	15.24	9.1
76 × 76	158.6	130.7	52.03	3.12	1.78	41.62	13.60	9.1

In calculating the net movement of inertia, one hole is deducted from each fange.