(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITRY EXAMINATIONS 2021/2022 ACADEMIC YEAR

FIFTH YEAR SECOND SEMESTER SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND STRUCTURAL ENGINEERING

COURSE CODE: CSE 516

COURSE TITLE: DESIGN OF BRIDGES

DATE: 6TH OCTOBER **TIME: 3 – 5 P.M**

INSTRUCTIONS:

1. This paper contains FOUR questions
2. Attempt **QUESTION ONE** and any other **TWO** questions in SECTION B
3. Marks for each question are indicated in the parenthesis.
4. Where information is deemed to be missing, make and state reasonable assumptions.

Examination duration is **2 Hours**

MMUST observes ZERO tolerance to examination cheating

SECTION A (COMPULSORY)- Answer all question in this section.

Question 1 (30 marks)

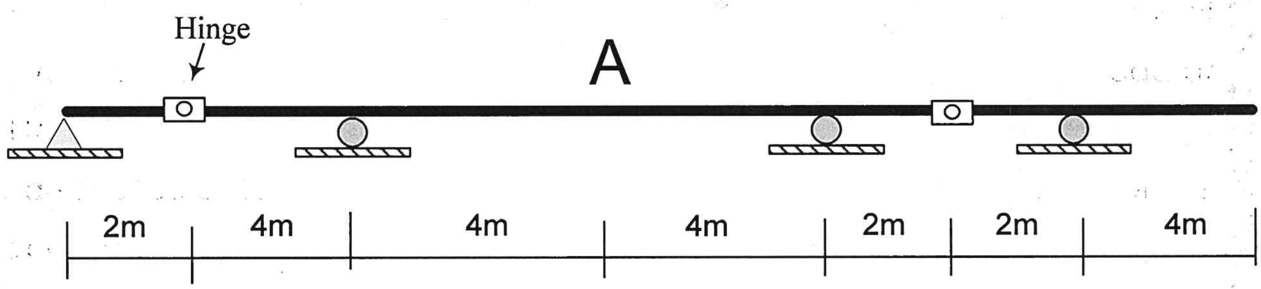
i. Discuss the useful preliminary data/ information required for planning of a new bridge. (10 marks)
ii. Discuss the type of materials used for bridge construction including challenges in their use and possible mitigation measures (10marks)
iii. Describe the basic types of bridge inspection, highlighting the possible bridge defects. (10 marks)

SECTION B- answer any TWO questions in this section.

Question 2 (25 marks)

Considering the point of interest, point A, construct the influence line for moving load of 50kN for the following:

i. Maximum positive bending moment at A (7marks)
ii. Maximum negative bending moment at A(8marks)
iii. Maximum positive shear force at A(5marks)
iv. Maximum negative shear force at A(5marks)



Question 3 (25 marks)

Design a simply supported reinforced concrete deck slab using the unit strip method. The deck carries a 100mm depth of surfacing, together with a nominal HA live load udl (uniform distributed load) of 16.0 kN/m^2 and knife edge load of 28kN/m .

The deck should also be designed to carry 30 units of HB load. The span of the deck is 12.0m centre to centre of bearings.

Density of concrete = 25kN/m³

30 units of HB also to be considered.

Use C32/40 concrete to BS 8500.

Use Grade B500B reinforcement to BS 4449.

Nominal cover for C32/40 concrete = 60mm

(**Design the main reinforcement for the Ultimate Limit State, NO NEED TO DO SERVICEABILITY CHECKS**)

Question 4 (25 marks)

Determine the following critical moments for 7 m wide bridge deck slab with a span of 36.5m.

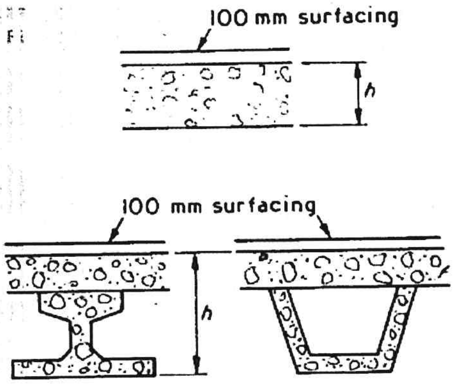
i. The maximum design bending moment per metre width due to HA loading for the bridge deck. (12 marks).
ii. The maximum design bending moment per metre width for the bridge due to 30 units of type HB loading (13 marks).

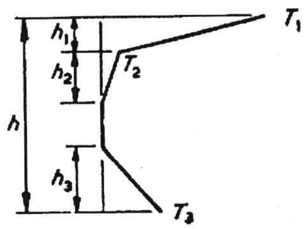
MEMORY AIDE

Load factors for serviceability and ultimate limit state from BS 5400 Part 2

		SLS		ULS	
		Comb 1	Comb 3	Comb 1	Comb 3
Dead Load	γ_{fL} concrete	1.0	1.0	1.15	1.15
Superimposed Dead Load	γ_{fL} surfacing	1.2	1.2	1.75	1.75
Live Load	γ_{fL} HA	1.2	1.0	1.5	1.25
	γ_{fL} HB	1.1	1.0	1.3	1.1
Temperature Difference	γ_{fL}	—	0.8	—	1.0#

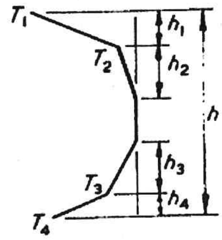
4. Concrete slab or concrete deck on concrete beams or box girders





$h_1 = 0.3h \leqslant 0.15$ m
$h_2 = 0.3h \geqslant 0.10$ m
$\leqslant 0.25$ m
$h_3 = 0.3h \leqslant$ (0.1 m+ surfacing depth in metres)
(for thin slabs, h_3 is limited by $h - h_1 - h_2$)

h	T_1	T_2	T_3
m	°C		
$\leqslant$0.2	8.5	3.5	0.5
0.4	12.0	3.0	1.5
0.6	13.0	3.0	2.0
$\geqslant$0.8	13.5	3.0	2.5



$h_1 = h_4 = 0.2h \leqslant 0.25$ m
$h_2 = h_3 = 0.25h \leqslant 0.2$ m

h	T_1	T_2	T_3	T_4
m	°C			
$\leqslant$0.2	2.0	0.5	0.5	1.5
0.4	4.5	1.4	1.0	3.5
0.6	6.5	1.8	1.5	5.0
0.8	7.6	1.7	1.5	6.0
1.0	8.0	1.5	1.5	6.3
$\geqslant$1.5	8.4	0.5	1.0	6.5

Figure 9. Temperature difference for different types of construction

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6.2 **Type HA loading.** Type HA loading consists of a uniformly distributed load (see 6.2.1) and a knife edge load (see 6.2.2) combined, or of a single wheel load (see 6.2.5).

6.2.1 **Nominal uniformly distributed load (UDL).** For loaded lengths up to and including 50m the UDL, expressed in kN per linear metre of notional lane, shall be derived from the equation,

$$W = 336\left(\frac{1}{L}\right)^{0.67}$$

and for loaded lengths in excess of 50m but less than 1600m the UDL shall be derived from the equation,

$$W = 36\left(\frac{1}{L}\right)^{0.1}$$

where L is the loaded length (in m) and W is the load per metre of notional lane (in kN).

For loaded lengths above 1600m, the UDL shall be agreed with the appropriate authority.

Values of the load per linear metre of notional lane are given in table 13 and the loading curve is illustrated in figure 10.

3.4.4.3 *Symbols*

For the purposes of 3.4.4 the following symbols apply.

A_s area of tension reinforcement.
A_s' area of compression reinforcement.
b width or effective width of the section or flange in the compression zone.
b_w average web width of a flanged beam.
d effective depth of the tension reinforcement.
d' depth to the compression reinforcement.
h_f thickness of the flange.
M design ultimate moment.
x depth to the neutral axis.
z lever arm.
β_b the ratio:

$$\frac{\text{(moment at the section after redistribution)}}{\text{(moment at the section before redistribution)}}$$

from the respective maximum moments diagram.

3.4.4.4 *Design formulae for rectangular beams*

The following equations, which are based on the simplified stress block of Figure 3.3, are also applicable to flanged beams where the neutral axis lies within the flange:

K' = 0.156 where redistribution does not exceed 10 % (this implies a limitation of the neutral axis depth to $d/2$); or
K' = $0.402(\beta_b - 0.4) - 0.18(\beta_b - 0.4)^2$ where redistribution exceeds 10 %;

and $K = M/bd^2f_{cu}$.

If $K \leq K'$, compression reinforcement is not required and:

$$z = d\left\{0.5 + \sqrt{\left(0.25 - \frac{K}{0.9}\right)}\right\}$$

but not greater than $0.95d$.

$x = (d - z)/0.45$
$A_s = M/0.95f_y z$

If $K > K'$, compression reinforcement is required and:

$$z = d\left\{0.5 + \sqrt{\left(0.25 - \frac{K'}{0.9}\right)}\right\}$$

$x = (d - z)/0.45$
$A_s' = (K - K')f_{cu}bd^2/0.95f_y(d - d')$
$A_s = (K'f_{cu}bd^2/0.95f_y z + A_s'$

If d'/x exceeds 0.37 (for f_y = 460 N/mm²), the compression stress will be less than $0.95f_y$ and should be obtained from Figure 2.2.
