(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2021/2022 ACADEMIC YEAR

THIRD YEAR SEMESTER TWO MAIN EXAMINATIONS

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

COURSE CODE: CSE 314

COURSE TITLE: STRUCTURAL TIMBER DESIGN

DATE: TUESDAY 19TH APRIL 2022 TIME: 12.00 – 2.00 PM

INSTRUCTIONS:

1. This paper contains **FOUR** questions
2. QUESTION ONE IS COMPULSORY
3. Attempt any other TWO questions
4. BS 5628 & EC5 is allowed
5. Marks for each question are indicated in the parenthesis.

Examination duration is **2 Hour**

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over.

Question ONE (10 marks)

(a) A 75×300 mm simply supported solid timber beam of length 6.4 m and strength class C22 is used for the construction of a residential house. The beam supports uniformly distributed permanent action (excluding self-weight), variable action and an independent variable concentrated action of 3.0 kN/m, 2.4 kN/m and 23 kN respectively. Calculate the values of the Design shear force V_D and design bending moments, M_d **(6 marks)**

$$\textit{Hint: } F_{E,d} = \sum_{j\geq 1} \gamma_{G,j} G_{k,j} + \gamma_{Q,1} Q_{K,1} + \sum_{i>1} \gamma_{Q,i} \varphi_{0,i} Q_{k,i}$$

(b) Define glued laminated timber and state THREE advantages of glulam members **(4 marks)**

Question TWO (20 marks)

(a) A 75 mm by 250 mm deep sawn timber beam **(Figure Q2a)** in a domestic residence supports the characteristic uniformly distributed permanent action ($G_{k,udl}$) (excluding self-weight), Medium term variable action $Q_{k,udl}$ and an independent Permanent concentrated action $G_{k,p}$ of 0.8 kN/m, 2.3 kN/m and 1.1 kN respectively. The beam has a clear span of 2.8 m, the bearing length has been restricted to 100 mm at each end, is of strength class C27 to BS EN 338:2003, and functions in service class 2 conditions. The beam is laterally restrained against lateral buckling along its length and is notched at its ends by 20 mm, extending 175 mm into the beam from the centre of each support position. The notches are on the same side as the beam supports. Carry out a design check to confirm that the beam will meet the ULS design requirements of EC5. **(17 marks)**

(b) Giving their characteristics, describe the differentiate between softwood and hardwood commercial timbers **(3 marks)**

Question THREE (20 marks)

(a) What do you understand by grading of timber? Differentiate between visual strength grading and machine strength grading criterion **(5 marks)**

(b) A timber-plywood gusset plate apex joint for the connection shown in **Figure Q3b** is to be designed using 12-mm-thick Finnish birch plywood with a characteristic density of 630 kg/m3 and fixed with the face grain horizontal. The joint fasteners are 3.50 mm diameter by 55 mm long smooth round wire nails, fixed without pre-drilling, with a tensile strength of 650 N/mm^2 and act in single shear. The timber members are strength class C18 to BS EN 338:2003 and the sizes are as shown in **Figure Q3b**. The joint will function under service class 2 conditions. The joint is subjected to design loading as shown, arising from a combination of permanent and medium-term variable actions. You are required to determine the Embedment strength of timber $f_{h,k}$, Yield moment of a nail $M_{y.Rk}$ and the Withdrawal resistance $F_{ax.Rk}$ required for the determination of Load-carrying capacity of connection. Also check for the strength of plywood gusset plates. **(15 marks)**

Question FOUR (20 marks)

(a) The glulam column shown in **Figure Q4a** is made from combined glulam grade GL 24c to BS EN 1194:1999, has a cross-section of 125 mm× 450 mm, and functions under service class 2 conditions. It supports a characteristic

permanent compressive action (including an allowance for the effect of its self-weight) of 35 kN and a characteristic variable medium-term compressive action of 70 kN. The column is 4.0 m high and at each end it is effectively held in position but not in direction about the z–z axis and the y–y axis. The axial load is offset from the centroid of the column as shown in the figure. Check that the column will comply with the ULS requirements of EC5. **(16 marks)**

(b) Discuss the permissible stress design and state its major drawback **(4 marks)**

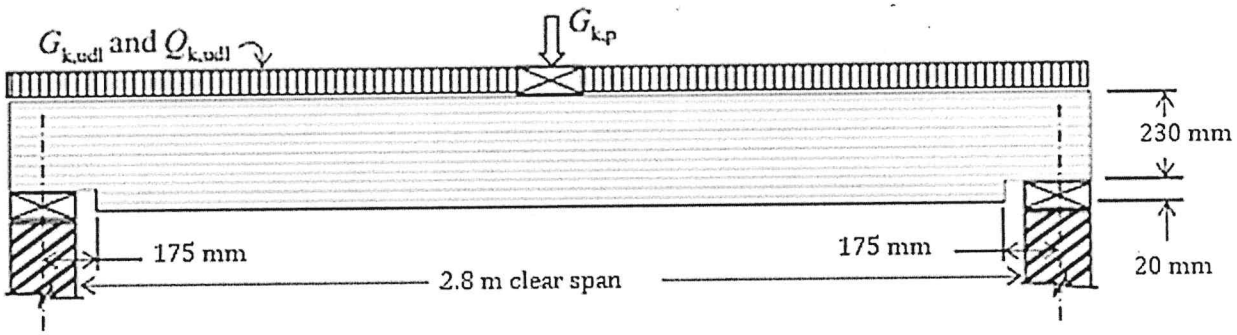

Figure Q2a

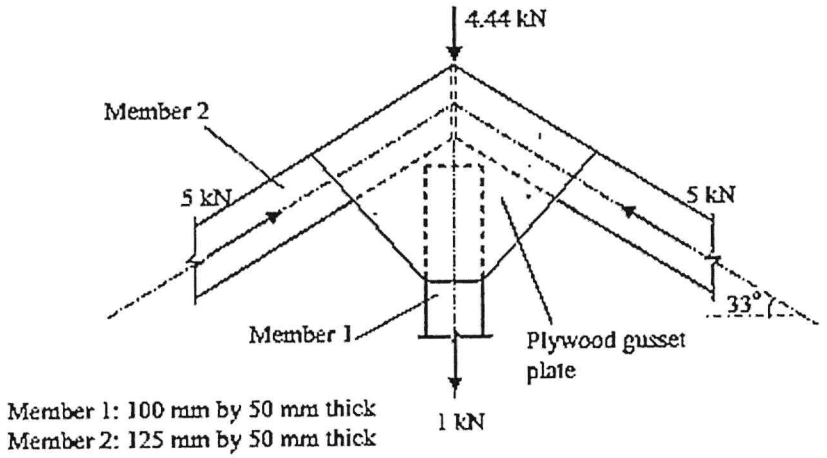

Figure Q3b

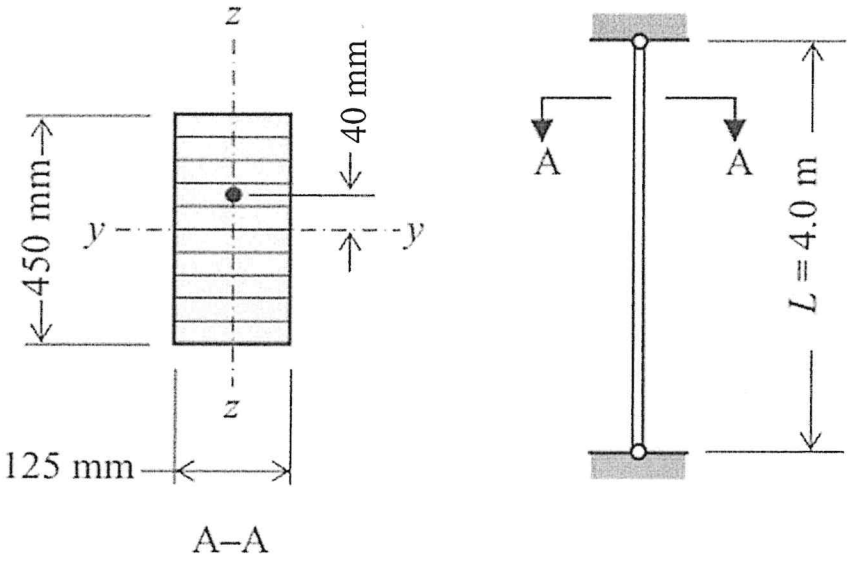

Figure Q4a