NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF ARCHITECTURE AND QUANTITY SURVEYING

DEPARTMENT OF ARCHITECTURE
BACHELOR OF ARCHITECTURAL STUDIES (HONOURS) DEGREE

PART II - FIRST SEMESTER EXAMINATIONS - DECEMBER 2000
AAR 2105 - STRUCTURAL DESIGN 1

Instructions **Time: 3 hours**

1. *Answer four (4) questions*
2. *Question number 5 is compulsory*
3. *Each question carries 25 marks*

QUESTIONS

Question 1

The word "Design" is used to describe the whole creative process of finding a safe and efficient solution to an engineering problem out of the infinite number of solutions.

i) With the aid of sketch diagrams illustrate three (3) different solutions you would recommend to provide a bridge across a 20m wide river [4 each]

ii) What are the possible construction materials you would use for the bridge [3]

iii) Fig. 1 shows the corner of a warehouse building which is supported on a short brickwork column. The load on the column is estimated to be as follows.

Load from weight of building = 600KN
Load contents of the building = 450KN

Determine the required cross-sectional area of the column if the design is based on:

a) Permissible stress principles
Permissible basic stress of column is 3.3 N/mm ^{2} [5]

b) Limit state principles
Design strength of column 6.0 N/mm ^{2} [5]

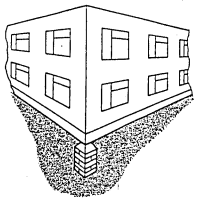

Fig. 1

Question 2

i) Fig. 2 shows some traction weights (loads in Kg) being applied to a patient's leg

a) Determine the forces in the cables in Newtons [4]

b) Find the total horizontal and vertical components of the forces [4]

c) Determine the magnitude and direction of the resultant force [4]

d) If the cables are 1.5mm diameter, what is the stress in the cable [3]

ii) For the structure shown in fig. 3 determine:-

a) The support reactions at A and C [4]

b) The stress in the vertical rod [3]

c) The extension of the vertical rod in mm if the rod has a modulus of elasticity, E of 205 000N/mm^2 [3]

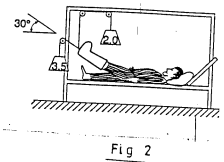

Fig 2

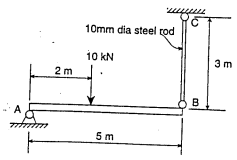

Fig 3

Question 3

i) Fig. 4 shows part of a tower crane where the counter weight is supported by an inclined tie as shown. The characteristic dead load weight of the counter weight is 150kN. Ignore the self weight of the crane structure and any other loads that may be acting.

Determine

a) The design tensile force in the tie

b) The required width of a 20 mm thick mild steel tie. [6]

Design strength of mild steel is 275N/mm²

ii) (a) Axially loaded compression members can fail in two principal ways. Explain these two ways and how failure can be prevented in each category. [3]

(b) A short reinforced concrete column measures 400 mm x 400 mm and contains four (4) 25 mm diameter high yield reinforcing bars (fy = 460N/mm²). If the concrete characteristic strength is 40N/mm² determine the ultimate axial design capacity of the column. [10]

[6]

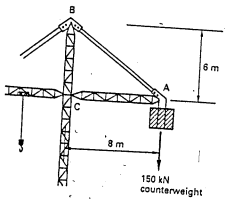

Fig 4

Question 4

i) Beams can be defined by the way they are supported. With the aid of sketches discuss the three most common type of beams and explain their behaviour under vertical loads [9]

ii) Explain with the aid of sketches, the circumstances under which steel box girder beams are commonly used. [6]

iii) Laminated timber or plywood box beams can be used for construction under certain circumstances

(a) Sketch a diagram showing each of the above beams [6]

(b) Discuss the advantages and disadvantages of using timber beams over other forms of construction such as steel or concrete beams. [4]

Question 5

For each of the beams shown in figure 5 a-b, draw the shear force and bending moment diagrams. Indicate the magnitude of <u>all</u> peak values. [12 ½]

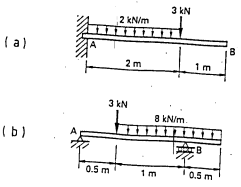

Fig 5