NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY DEPARTMENT OF CIVIL AND WATER ENGINEERING FACULTY OF INDUSTRIAL TECHNOLOGY BACHELOR OF ENGINEERING (HONOURS) DEGREE PART III FIRST SEMESTER EXAMINATION- DECEMBER 2006 DESIGN OF STRUCTURES I– TCW 3103

INSTRUCTION

Answer Four Questions

Open Book Examination

Time: 4 hours

Total Marks 100

QUESTION ONE

- (a) Derive from first principles the following equation for the ultimate moment of resistance (M_u) of a singly reinforced concrete section assuming a rectangular stress-block distribution $M_u = 0.156 f_{cu}bd^2$ Marks 10
- (b) Design the bending and shear reinforcement for a simply supported beam using the following information

Span l = 7.0 m;
$$g_k = 20 \text{ kN/m}$$
; $q_k = 10 \text{ kN/m}$
 $f_{cu} = 25 \text{ N/mm}^2$; $f_v = 460 \text{ N/mm}^2$; $f_{vv} = 250 \text{ N/mm}^2$ Marks 15

QUESTION TWO

(a) Explain the difference between a short and a slender column

Marks 10

- (b) An internal column in a multi-storey building supporting an approximately symmetrical arrangement of beams carries an ultimate load of 2000 kN. Assuming that the column is square, short and braced, calculate
 - (i) a suitable cross section for the column
 - (ii) the area of the longitudinal reinforcement
 - (iii) the size and spacing of the ties

$$f_{cu} = 30 \text{ N/mm}^2$$
; $f_y = 460 \text{ N/mm}^2$ Marks 15

QUESTION THREE

A simply supported beam of span 10.0 m supports a uniformly distributed characteristic dead and imposed load of 5 kN/m. It also supports a characteristic imposed point load of 30 kN at mid-span. Assuming the beam is fully restrained laterally, select a suitable UB section in grade 43 steel to satisfy bending and shear considerations.

Marks 25

QUESTION FOUR

A proposed 5.0 m long internal column in a rigid jointed steel structure is to be loaded concentrically with a characteristic dead and imposed load of 1000 kN each. Assuming that the fixity at the top and bottom of the column gives effective rotational restraint, design a column section assuming the structure will be (a) braced and (b) unbraced

Marks 25

QUESTION FIVE

A timber beam with an effective span of 3.0 m supports a uniformly distributed load of 10 kN including self weight of the beam. Determine a suitable section for the beam using timber of strength class SC3. Assume that the beam is held in position.

Assume the following

Strength Class of timber SC 3		Modification Factors:		
For SC 3 Grade			K3, duration o	of loading 1.0
Bending stress parallel to grain	=	5.3 N/mm ²	K8 Load sharing system 1.1	
Shear stress parallel to grain	=	0.67 N/mm ²	K7 Depth factor	
			for $d = 250$	1.02
Modulus of Elasticity E	=	5800 N/mm ²	for $d = 225$	1.032
Long term loading			for $\mathbf{d} = 200$	1.046

Marks 25