# 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 $\left(\mathbf{M}_{u}\right)$ of a singly reinforced concrete section assuming a rectangular stress-block distribution

$$
\mathbf{M}_{u}=0.156 \mathbf{f}_{\mathrm{cu}} \mathbf{b d}^{2}
$$

Marks 10
(b) Design the bending and shear reinforcement for a simply supported beam using the following information

Span l = $7.0 \mathrm{~m} ; \quad \mathrm{g}_{\mathrm{k}}=20 \mathrm{kN} / \mathrm{m} ; \quad \mathrm{q}_{\mathrm{k}}=10 \mathrm{kN} / \mathrm{m}$
$f_{\mathrm{cu}}=25 \mathrm{~N} / \mathrm{mm}^{2} ; \quad \mathrm{f}_{\mathrm{y}}=460 \mathrm{~N} / \mathrm{mm}^{2} ; \mathrm{f}_{\mathrm{yv}}=250 \mathrm{~N} / \mathrm{mm}^{2}$
Marks 15

## QUESTION TWO

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

$$
f_{\mathrm{cu}}=30 \mathrm{~N} / \mathrm{mm}^{2} ; \quad \mathrm{f}_{\mathrm{y}}=460 \mathrm{~N} / \mathrm{mm}^{2}
$$

## QUESTION THREE

A simply supported beam of span 10.0 m supports a uniformly distributed characteristic dead and imposed load of $5 \mathrm{kN} / \mathrm{m}$. 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 |  | Modificatio | ctors: |
| :---: | :---: | :---: | :---: |
| For SC 3 Grade |  | K3, duration | f loading 1.0 |
| Bending stress parallel to gra | $=5.3 \mathrm{~N} / \mathrm{mm}^{2}$ | K8 Load sha | ing system 1.1 |
| Shear stress parallel to grain | $=0.67 \mathrm{~N} / \mathrm{mm}^{2}$ | K7 Depth |  |
|  |  | for $\mathbf{d}=250$ | 1.02 |
| Modulus of Elasticity E | $=5800 \mathrm{~N} / \mathrm{mm}^{2}$ | for $d=225$ | 1.032 |
| Long term loading |  | for $d=200$ | 1.046 |




