

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY  
DEPARTMENT OF CIVIL AND WATER ENGINEERING  
FACULTY OF INDUSTRIAL TECHNOLOGY  
BACHELOR OF ENGINEERING (HONOURS) DEGREE  
PART III SUPPLEMENTARY EXAMINATION- OCTOBER 2009  
DESIGN OF STRUCTURES I- TCW 3103

**INSTRUCTION**

**Answer Four Questions**

**Time: 4 hours**

**Open Book Examination**

**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

$$M_u = 0.156 f_{cu} b d^2$$

**Marks 10**

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

$$\text{Span } l = 7.0 \text{ m}; \quad g_k = 20 \text{ kN/m}; \quad q_k = 10 \text{ kN/m}$$

$$f_{cu} = 25 \text{ N/mm}^2; \quad f_y = 460 \text{ N/mm}^2; \quad f_{yv} = 250 \text{ N/mm}^2$$

**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

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

**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

For SC 3 Grade

Bending stress parallel to grain =  $5.3 \text{ N/mm}^2$

Shear stress parallel to grain =  $0.67 \text{ N/mm}^2$

Modulus of Elasticity E =  $5800 \text{ N/mm}^2$

Long term loading

Modification Factors:

K3, duration of loading 1.0

K8 Load sharing system 1.1

K7 Depth factor

for d = 250 1.02

for d = 225 1.032

for d = 200 1.046

Marks 25



