MACHAKOS UNIVERSITY

DEPARTMENT OF BUILDING AND CIVIL ENGINEERING

DEGREE OF BACHELOR OF SCIENCE

YEAR 3 SEMESTER II EXAMINATIONS MAY 2019

ECV 412: DESIGN II

Instructions to candidates

- This paper consists of **FIVE** questions.
- All symbols have their usual meaning unless otherwise stated
- Only relevant design codes are allowed
- Attempt question one and any other two questions

QUESTION ONE (30 Marks)

(i) List four types of foundations that may be used in construction of reinforced concrete structures. (**4 Marks**)

(ii) Clearly describe two ways that may be used to achieve pre-stressing in concrete construction. (**8 Marks**)

(iii) A solid footing has to transfer a dead load of 1000 kN and an imposed load of 400 kN from a square column 400 x 400 mm (with 16 mm bars). Assuming f_y = 415, and f_{ck} = 20 N/mm^2, and safe bearing capacity to be 200 kN/m^2, design the footing. (**18 Marks**)

QUESTION TWO (20 Marks)

(i) State five serviceability limit states that may be considered during design. (**5 Marks**)

(ii) Design the longitudinal and shear reinforcement for a 275 mm square, short-braced column which supports an ultimate axial load of 1280 kN and bending moments of 35 kNm about the x-x axis and 25 kNm about the y-y axis. Assume f_{cu} = 30 N/mm^2 and f_y = 460 N/mm^2 and cover to all reinforcement is 35 mm. (**15 Marks**)

QUESTION THREE (20 Marks)

Design a reinforced concrete slab 6.3 x 4.5 m simply supported on all the four sides. It has to carry a characteristic live load of 10 kN/m^2 in addition to its dead weight. Assume C25 concrete and f_y = 415 N/mm^2; also assume that the exposure condition to environment can be classified as mild. (**20 Marks**)

QUESTION FOUR (20 Marks)

(i) Design the longitudinal steel and links for a 300 mm square reinforced concrete column, short-braced which is to carry an ultimate load of 1400 kN, with the following material properties; f_{cu} = 25 N/mm^2 and f_y = 460 N/mm^2. (**14 Marks**)

(ii) State any three ways in which a reinforced concrete column may fail under loading. (**6 Marks**)

QUESTION FIVE (20 Marks)

A reinforced concrete beam has an overall depth of 500 mm and width of 300 mm. The beam is simply supported on 200 mm wide walls and spans 6 m. The beam is exposed to mild conditions. The beam is to carry an imposed load of 25 kN/m and a dead load of 15 kN/m (including self-weight). Assume f_{cu} =30 N/mm^2, f_y = 460 N/mm^2 and f_{yv} = 250 N/mm^2, design the beam together with the shear reinforcement. (**20 Marks**)

Table 3.10 Cross-sectional areas of groups of bars (mm^2)

Bar size (mm)	*Number of bars*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
6	28.3	56.6	84.9	113	142	170	198	226	255	283
8	50.3	101	151	201	252	302	352	402	453	503
10	78.5	157	236	314	393	471	550	628	707	785
12	113	226	339	452	566	679	792	905	1020	1130
16	201	402	603	804	1010	1210	1410	1610	1810	2010
20	314	628	943	1260	1570	1890	2200	2510	2830	3140
25	491	982	1470	1960	2450	2950	3440	3930	4420	4910
32	804	1610	2410	3220	4020	4830	5630	6430	7240	8040
40	1260	2510	3770	5030	6280	7540	8800	10100	11300	12600

Table 3.22 Cross-sectional area per metre width for various bar spacing (mm^2)

Bar size (mm)	*Spacing of bars*								
	50	*75*	*100*	*125*	*150*	*175*	*200*	*250*	*300*
6	566	377	283	226	189	162	142	113	94.3
8	1010	671	503	402	335	287	252	201	168
10	1570	1050	785	628	523	449	393	314	262
12	2260	1510	1130	905	754	646	566	452	377
16	4020	2680	2010	1610	1340	1150	1010	804	670
20	6280	4190	3140	2510	2090	1800	1570	1260	1050
25	9820	6550	4910	3930	3270	2810	2450	1960	1640
32	16100	10700	8040	6430	5360	4600	4020	3220	2680
40	25100	16800	12600	10100	8380	7180	6280	5030	4190

Table 3.13 Values of A_{sv}/s_v

Diameter (mm)	*Spacing of links* (mm)										
	85	*90*	*100*	*125*	*150*	*175*	*200*	*225*	*250*	*275*	*300*
8	1.183	1.118	1.006	0.805	0.671	0.575	0.503	0.447	0.402	0.366	0.335
10	1.847	1.744	1.57	1.256	1.047	0.897	0.785	0.698	0.628	0.571	0.523
12	2.659	2.511	2.26	1.808	1.507	1.291	1.13	1.004	0.904	0.822	0.753
16	4.729	4.467	4.02	3.216	2.68	2.297	2.01	1.787	1.608	1.462	1.34