NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF BUILT ENVIRONMENT

DEPARTMENT ARCHITECTURE

STRUCTURAL DESIGN II

AAR 2205

May 2017

This examination paper consists of 6 pages

Time Allowed: **3 hours**

Total Marks: **100**

Special Requirements: **GRAPH PAPER, TABLES**

Examiner's Name: **Eng. V.V. DESAI**

INSTRUCTIONS

1. Answer all questions
2. Use of calculators is permissible

MARK ALLOCATION

QUESTION	MARKS
1.	**25**
2.	**25**
3.	**25**
4.	**25**
TOTAL	**100**

QUESTION ONE

A simply supported reinforced concrete slab spans 5.0 m. Design a suitable slab using grade 25 concrete and grade 460 reinforcement to support the following loads

Imposed 4.0kN/ m^2

Finishes 0.5kN/ m^2

QUESTION TWO

A short column supports a characteristic dead load of 650 kN and a characteristic live load of 450 kN, column being 250mm x 250mm. Design a suitable isolated foundation for the column assuming the following:

Permissible soil pressure 150kN/ m^2

Grade 30 concrete and Grad 460 reinforcement

QUESTION THREE

A simply supported beam spanning 8m has a uniformly distributed characteristic dead and characteristic live load of 20kNm and 10kN/m respectively. Assuming the beam is fully restrained laterally, select a suitable UB section in Grade 43 steel to satisfy the bending and shear considerations.

QUESTION FOUR

a. What are "characteristic loads?" [5]

b. Define partial safety factors and describe why they are sued in design. [5]

c. What are the partial safety factors for dead and live loads [5]

d. Explain the difference between characteristic loads and design loads. [5]

e. Explain the difference between Ultimate Moment of Resistance and Design Moment. [5]

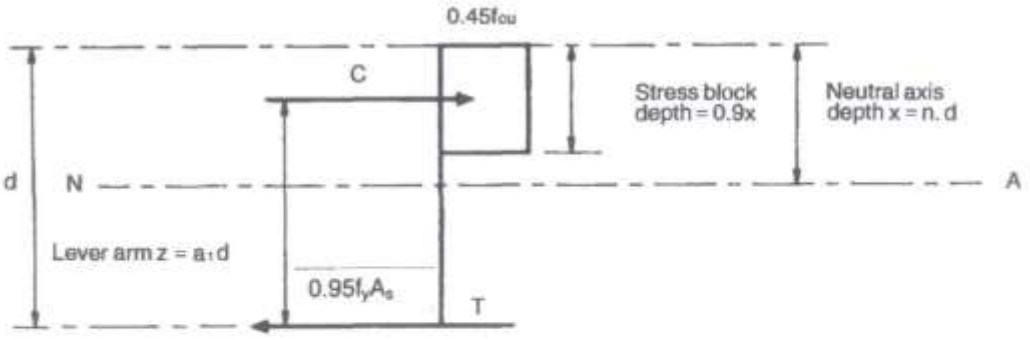

Fig. 6 Stress diagram

The area of tension reinforcement is then given by:

$$A_s = \frac{M}{(0.95f_y)z}$$

where z is obtained from Table 14.
For two-way spanning slabs, care should be taken to use the value of d appropriate to the direction of the reinforcement.

Table 14 Lever arm and neutral axis depth factors for slabs

$K = M/bd^2f_{cu}$	0.05	0.06	0.07	0.08	0.09	0.100	0.104	0.110	0.119	0.130	0.132	0.140	0.144	0.150	0.156
$a_1 = (z/d)$	0.94	0.93	0.91	0.90	0.89	0.87	0.87	0.86	0.84	0.82	0.82	0.81	0.80	0.79	0.775
$n = (x/d)$	0.13	0.16	0.19	0.22	0.25	0.29	0.30	0.32	0.35	0.39	0.40	0.43	0.45	0.47	0.50
	30%							25%		20%		15%		0-10%	
	→							→		→		→		→	
Limit of Table for various % of moment redistribution															

(b) The spacing of main bars should not exceed the lesser of:

$$3d,\ 300\text{mm},\ \text{or}\ \frac{70000\beta}{pf_y}$$

where p is the reinforcement percentage and $0.3 < p < 1.0$ and

β is the ratio: $\dfrac{\text{moment after redistribution}}{\text{moment before redistribution}}$

If $p \geq 1$ use $p = 1$ in formula above.
Spacing of distribution bars should not exceed the lesser of:

$3d$ or 400mm.

Table 3.10 Cross-sectional areas of groups of bars (mm²)

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 (mm²)

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

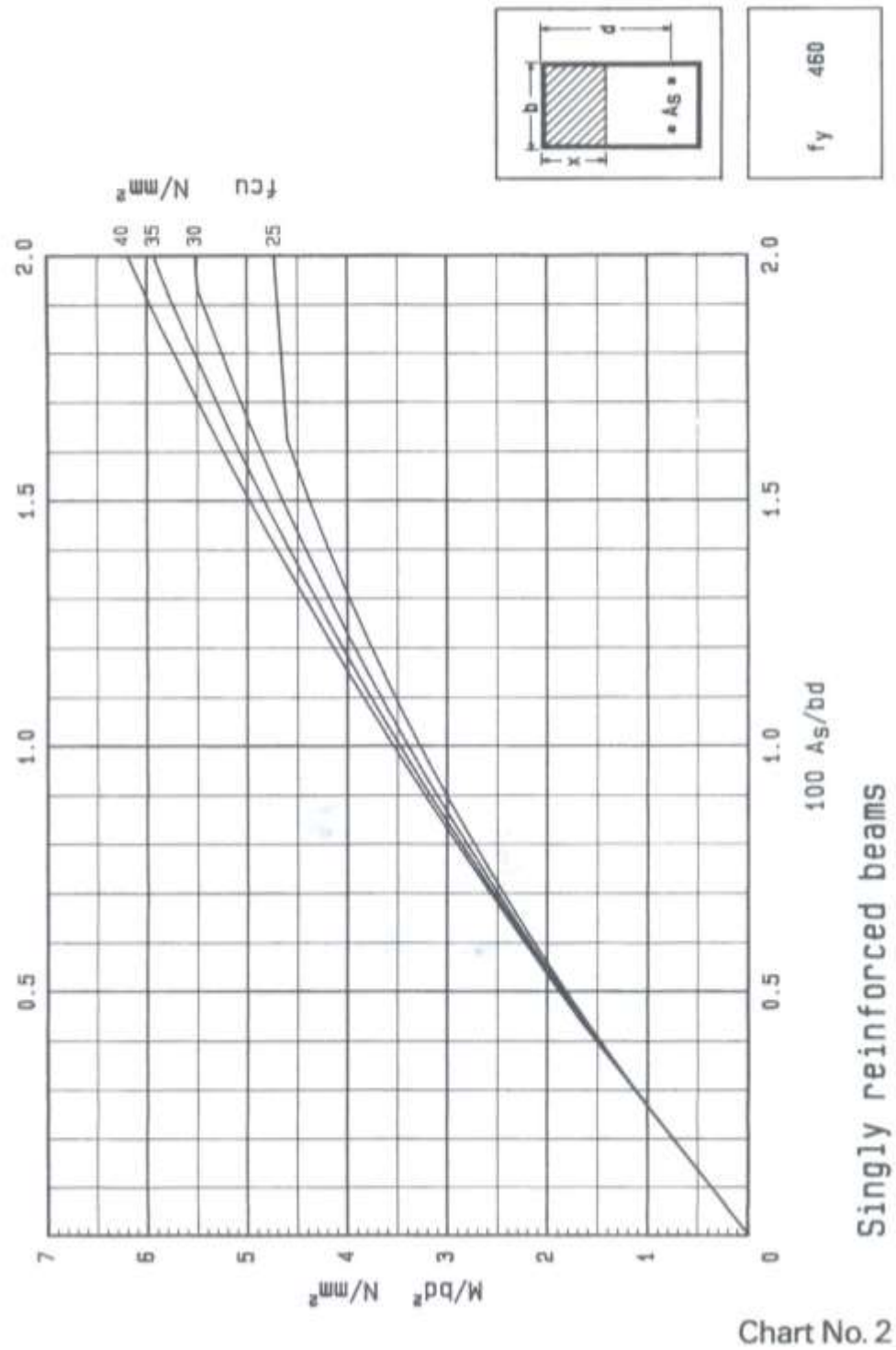

Chart No. 2

UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Serial Size	Mass per metre	Depth of Section D	Width of Section B	Thickness Web t	Thickness Flange T	Root Radius r	Depth between Fillets d	Area of Section
mm	kg	mm	mm	mm	mm	mm	mm	cm^2
457 × 152	82	465.1	153.5	10.7	18.9	10.2	404.4	104.4
	74	461.3	152.7	9.9	17.0	10.2	404.4	94.9
	67	457.2	151.9	9.1	15.0	10.2	404.4	85.3
	60	454.7	152.9	8.0	13.3	10.2	407.7	75.9
	52	449.8	152.4	7.6	10.9	10.2	407.7	66.5
406 × 178	74	412.8	179.7	9.7	16.0	10.2	357.4	94.9
	67	409.4	178.8	8.8	14.3	10.2	357.4	85.4
	60	406.4	177.8	7.8	12.8	10.2	357.4	76.1
	54	402.6	177.6	7.6	10.9	10.2	357.4	68.3
406 × 152	74	416.3	153.7	10.1	18.1	10.2	357.4	94.8
	67	412.2	152.9	9.3	16.0	10.2	357.4	85.3
	60	407.9	152.2	8.6	13.9	10.2	357.4	75.8
406 × 140	46	402.3	142.4	6.9	11.2	10.2	357.4	58.9
	39	397.3	141.8	6.3	8.6	10.2	357.4	49.3
381 × 152	67	388.6	154.3	9.7	16.3	10.2	333.2	85.4
	60	384.8	153.4	8.7	14.4	10.2	333.2	75.9
	52	381.0	152.4	7.8	12.4	10.2	333.2	66.4
356 × 171	67	364.0	173.2	9.1	15.7	10.2	309.1	85.3
	57	358.6	172.1	8.0	13.0	10.2	309.1	72.1
	51	355.6	171.5	7.3	11.5	10.2	309.1	64.5
	45	352.0	171.0	6.9	9.7	10.2	309.1	56.9
356 × 127	39	352.8	126.0	6.5	10.7	10.2	309.1	49.3
	33	348.5	125.4	5.9	8.5	10.2	309.1	41.7
305 × 165	54	310.9	166.8	7.7	13.7	8.9	262.6	68.3
	46	307.1	165.7	6.7	11.8	8.9	262.6	58.8
	40	303.8	165.1	6.1	10.2	8.9	262.6	51.4
305 × 127	48	310.4	125.2	8.9	14.0	8.9	262.6	60.8
	42	306.6	124.3	8.0	12.1	8.9	262.6	53.1
	37	303.8	123.5	7.2	10.7	8.9	262.6	47.4
305 × 102	33	312.7	102.4	6.6	10.8	7.6	275.3	41.8
	28	308.9	101.9	6.1	8.9	7.6	275.3	36.3
	25	304.8	101.6	5.8	6.8	7.6	275.3	31.4
254 × 146	43	259.6	147.3	7.3	12.7	7.6	216.2	55.0
	37	256.0	146.4	6.4	10.9	7.6	216.2	47.4
	31	251.5	146.1	6.1	8.6	7.6	216.2	39.9
254 × 102	28	260.4	102.1	6.4	10.0	7.6	224.5	36.2
	25	257.0	101.9	6.1	8.4	7.6	224.5	32.1
	22	254.0	101.6	5.8	6.8	7.6	224.5	28.4
203 × 133	30	206.8	133.8	6.3	9.6	7.6	169.9	38.0
	25	203.2	133.4	5.8	7.8	7.6	169.9	32.3

UNIVERSAL BEAMS

DIMENSIONS AND PROPERTIES

Serial Size	Moment of Inertia Axis x–x Gross	Moment of Inertia Axis x–x Net	Moment of Inertia Axis y–y	Radius of Gyration Axis x–x	Radius of Gyration Axis y–y	Elastic Modulus Axis x–x	Elastic Modulus Axis y–y
mm	cm^4	cm^4	cm^4	cm	cm	cm^3	cm^3
457 × 152	36160	32058	1093	18.6	3.24	1555	[illegible]
	32380	28731	963	18.5	3.18	1404	[illegible]
	28522	25342	829	18.3	3.12	1248	[illegible]
	25464	22613	794	18.3	3.23	1120	[illegible]
	21345	18034	645	17.9	3.11	949.0	[illegible]
406 × 178	27279	23981	1448	17.0	3.91	1322	[illegible]
	24279	21357	1269	16.9	3.86	1186	[illegible]
	21520	18928	1108	16.8	3.82	1059	[illegible]
	18576	16389	922	16.5	3.67	922.8	[illegible]
406 × 152	26938	23811	1047	16.9	3.32	1294	[illegible]
	23798	21069	908	16.7	3.26	1155	[illegible]
	20619	18283	788	16.5	3.18	1011	[illegible]
406 × 140	15603	13699	500	16.3	2.92	775.6	[illegible]
	12408	10963	373	15.9	2.75	624.7	[illegible]
381 × 152	21276	18817	947	15.8	3.33	1095	[illegible]
	18632	16489	814	15.7	3.27	968.4	[illegible]
	16046	14226	685	15.5	3.21	842.3	[illegible]
356 × 171	19483	17002	1278	15.1	3.87	1071	[illegible]
	16038	14018	1026	14.9	3.77	894.3	[illegible]
	14118	12340	885	14.8	3.71	794.0	[illegible]
	12082	10578	730	14.6	3.58	684.7	[illegible]
356 × 127	10054	8688	333	14.3	2.60	570.0	[illegible]
	8167	7099	257	14.0	2.48	468.7	[illegible]
305 × 165	11686	10119	988	13.1	3.80	751.8	[illegible]
	9924	8596	825	13.0	3.74	646.4	[illegible]
	8500	7368	691	12.9	3.67	559.6	[illegible]
305 × 127	9485	8137	438	12.5	2.68	611.1	[illegible]
	8124	6978	367	12.4	2.63	530.0	[illegible]
	7143	6142	316	12.3	2.58	470.3	[illegible]
305 × 102	6482	5792	189	12.5	2.13	414.6	[illegible]
	5415	4855	153	12.2	2.05	350.7	[illegible]
	4381	3959	116	11.8	1.92	287.5	[illegible]
254 × 146	6546	5683	633	10.9	3.39	504.3	[illegible]
	5544	4814	528	10.8	3.34	433.1	[illegible]
	4427	3859	406	10.5	3.19	352.1	[illegible]
254 × 102	4004	3565	174	10.5	2.19	307.6	[illegible]
	3404	3041	144	10.3	2.11	264.9	[illegible]
	2863	2572	116	10.0	2.02	225.4	[illegible]
203 × 133	2880	2469	354	8.71	3.05	278.5	[illegible]
	2348	2020	280	8.53	2.94	231.1	[illegible]