Module (Course Syllabus) Catalogue

College/ Institute	**College of Erbil Technical Engineering**	
Department	**Civil Engineering**	
Module Name	**Reinforced Concrete Structures**	
Module Code	**RCS702**	
Degree	**Technical Diploma ☐ Bachler ■ High Diploma Master ☐ PhD ☐**	
Semester	**Fifth Semester**	
Qualification	**BSc Civil Engineering Techniques/ Erbil**	
Scientific Title	**Assistant Professor**	
ECTS (Credits)	**6**	
Module type	**Prerequisite Core Assist.**	
Weekly hours		
Weekly hours (Theory)	**(4)hr Class**	**(162)Total hrs Workload**
Weekly hours (Practical)	**( )hr Class**	**( )Total hrs Workload**
Number of Weeks	**12**	
Lecturer (Theory)	**no**	
E-Mail & Mobile NO.	**Email: bikhtiyar.abdulrahman@epu.edu.iq, Mobile: +9647504905357**	
Lecturer (Practical)		
E-Mail & Mobile NO.		
Websites		

Course Book

Course Description	Emphasis is placed on understanding structural behaviour and the background to the design methods in ACI and other codes where appropriate. By the end of this module students will have a good understanding of the design and behaviour of reinforced concrete structures.
Course objectives	The main aim and purpose behind the study of reinforced concrete structures is to give students a good understanding of the design and behaviour of reinforced concrete structures at the ultimate limit state. We will look at the design of framed building structures in some detail with particular emphasis on the design of torsion of beams, two-way slabs, shear walls, reinforced concrete tanks, Prestressed concrete and reinforced concrete bridges.
Student's obligation	The students are required to: -Attend all the lectures and participate in the classwork and assignments. -Participate in the exam.
Specific learning outcome:	On successful completion of this course, each student is able to: a) **Design of reinforced concrete Beam for Torsion** b) Design and check for serviceability (crack and deflection) conditions and for ultimate limit state conditions in accordance with relevant reinforced concrete design and building standards. c) **Design of reinforced concrete Two-way Slabs** d) Understand how structural components are assembled into complete structural systems of multi-storey buildings, including understanding the load paths and interactions between components e) Apply concepts for reinforced concrete and prestressed concrete design
Required Learning Materials	Different pedagogical methods are used in this course; for example, project, report, and homework, easy. Student will receive the required handouts such as the references.

<table>
<tr><th rowspan="15">Evaluation</th><th colspan="2">Tas
k</th><th>Weight (Marks)</th><th>Due Week</th><th>Relevant Learning Outcome</th></tr>
<tr><td colspan="2">Paper Review</td><td></td><td></td><td rowspan="8">All</td></tr>
<tr><td rowspan="7">Assignments</td><td>Homework</td><td>10
%</td><td></td></tr>
<tr><td>Class Activity</td><td>2%</td><td></td></tr>
<tr><td>Report</td><td></td><td></td></tr>
<tr><td>Seminar</td><td>8%</td><td></td></tr>
<tr><td>Essay</td><td></td><td></td></tr>
<tr><td>Project</td><td>8%</td><td></td></tr>
<tr><td colspan="2">Quiz</td><td>8%</td><td></td><td></td></tr>
<tr><td colspan="2">Lab.</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Midterm Exam</td><td>24
%</td><td></td><td></td></tr>
<tr><td colspan="2">Final Exam</td><td>40
%</td><td></td><td></td></tr>
<tr><td colspan="2">Total</td><td>100%</td><td></td><td></td></tr>
</table>

Course References:

1- ACI 318M-19" Building code requirements for structural concrete"
"Design of Concrete Structure "13th edition, Arthur H. Nilson, David Darwin
and Charles W. Dolan 2004.
2- "Reinforced Concrete Mechanics and Design" third edition, James G. Macgregor 1997.
3- "Reinforced Concrete Design of tall Buildings", Bungale S. Taranath, 2010.
4- "Reinforced Concrete a Fundamental approach" fifth edition, Edward G. Nawy 2005.

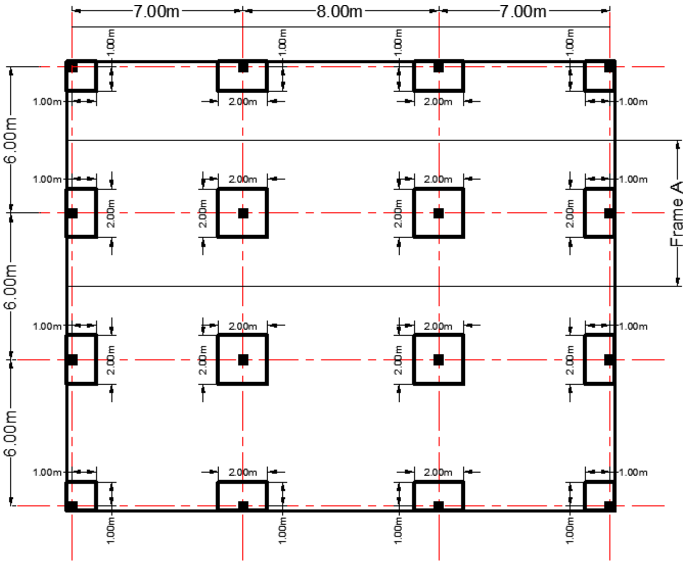
Course topics (Theory)	Week	Learning Outcome
Introduction Torsion in beams	1-2	a)
Beams Defection Control Beams Crack Control	3	b)
Method of Slab Analysis & Design. Direct Design Method. Equivalent Design Method.	4-7	c)
Method of Slab Analysis & Design. Equivalent Design Method.	8-9	c)
Multi-storey Buildings	10	d)
Pre-stress Concrete.	11-12	e)

Practical Topics	Week	Learning Outcome
N/A		

Questions Example Design

Q1/ A two-way slab floor system as shown below. It is divided into 9 panels. Cylindrical Concrete compressive strength, fc`=25MPa and steel yield strength, fy=420MPa. Additional dead load=1.0 kN/m^2, service live load is to be taken 3.0kN/m^2, story height is 3.70m. The preliminary sizes are as follows Slab thickness is 250mm, Slab thickness is 400mm at drops columns sizes are 400x400 mm. Determine

1- Minimum Slab Thickness according to ACI Code
2- Using Equivalent Frame Method Find column strip & Middle Strip (+ve and –ve) moments for Frame A
3- Find the Required steel and spacing for the maximum +ve & -ve moments of Frame A



Take

-Clear Cover for slab=20mm

-ϕ 12mm steel reinforcement used for slab reinforcement.

-B_t=0 (for determining column strip exterior negative factored moments).

Solution

Solution

1-

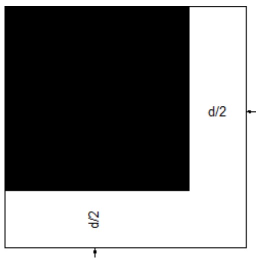
Maximum Span is 8.0m

Ln=8.0*0.4=7.60

m 1-Exterior Panels Ln/30

=7.6*1000/30=228mm

2-Interior Panels Ln/332=7.6*1000/33=230mm



2-

Wu=1.2d.l+1.6l.l=

Wu=1.2(0.275*24+1.0)1.6*3.0=13.92kN

/m^2 d=275-20-6=249mm

bo=2(400+249/2) =1049mm

a) $\phi V_c = [1 + \frac{2}{\beta_c}]\frac{\phi}{6}\sqrt{f'_c} * b_o * d$

$\phi V_c = [1 + \frac{2}{1}]\frac{0.75}{6}\sqrt{25} * 1049 * 249 = 489.75 kN$

b) $\phi V_c = [\frac{\alpha_s * d}{b_o} + 2]\frac{\phi}{12}\sqrt{f'_c} * b_o * d$

$\phi V_c = [\frac{20 * 249}{1049} + 2]\frac{0.75}{12}\sqrt{25} * 1049 * 249 = 550.76 kN$

c) $\phi V_c = \frac{\phi}{3}\sqrt{f'_c} * b_o * d$

$\phi V_c = \frac{0.75}{3}\sqrt{25} * 1049 * 249 = 326.50 kN$

Applied Vu=13.92*(3.5*3-0.5245*0.5245) =142.33kN < ϕVc ok

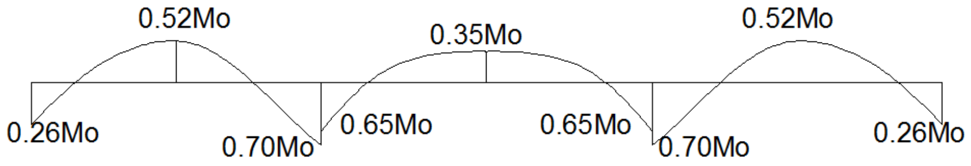
3.

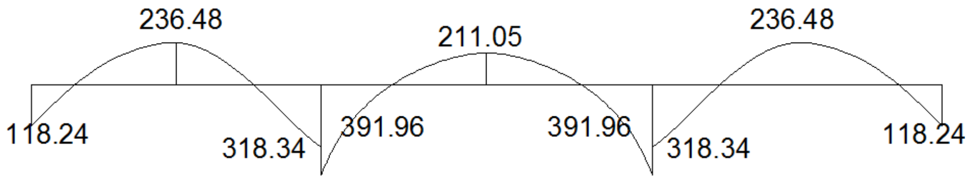
$Mo1=1/8*6*13.92*6.6^2=454.77$

kN.m

$Mo1=1/8*6*13.92*7.6^2=603.01$

kN.m





For Span 1

L2/L1=6/7=0.86m For

Span 2 L2/L1=6/8=0.75m

Ext Neg 100%

Inter Neg 95%

+Ve moment 60%

	Exter Span			Inter Span		
	Ext. -Ve	+Ve	-Ve	Neg	+Ve	Ve

Total Moment	118.24	236.48	318.34	39.96	211.05	391.96

Col Str.	118.24	141.89	238.76	293.97	126.63	293.97
Middle Str.	0	94.59	79.59	97.99	94.42	97.99

4.

$$\square = \left(1 - 0.63\frac{\square}{\square}\right)\frac{\square^3\square}{3} = \left(1 - 0.63\frac{275}{400}\right)\frac{275^3 * 400}{3} = 1571897135\,\square\square^4$$

$$\square\square = 4700\sqrt{\square`\square} = 4700\sqrt{25} = 23500\,\square\square\square$$

$$\mathbf{Kt} = \sum \frac{9E_{CS}C}{l_2\left(1 - \frac{C_2}{l_2}\right)^3}$$

$$\mathrm{Kt} = \sum \frac{9 * 23500 * 1571897135}{6000\left(1 - \frac{400}{6000}\right)^3} = 6.82 * 10^4\,\mathrm{kN.m}$$

Ic=400*400^3/12=2133333333mm^4

Kc=4EI/L=4*23500*2133333333/ (3.7*1000) =5.42*10^4

kN.m

$$\mathbf{Kec} = \frac{\sum \mathbf{Kc}}{\mathbf{1} + \frac{\sum \mathbf{Kc}}{\mathbf{Kt}}}$$

$$\mathrm{Kec} = \frac{2 * 5.42 * 10^4}{1 + \frac{2 * 5.42 * 10^4}{2 * 6.82 * 10^4}} = 6.04 * 10^4\,\mathrm{kN.m}$$

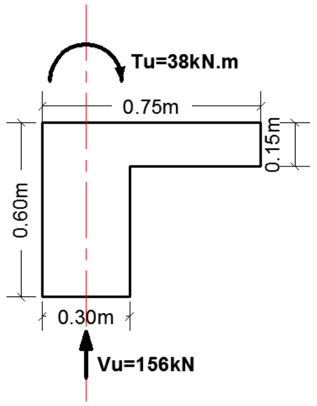
Q2/ Design the **vertical** steel reinforcements for the beams shown below taking the effect of **Torsion** and **Shea**r loads having f\`c= 28 MPa and fy= 414MPa the beams <u>(30 marks)</u>

Take

-Clear Cover for beam=40mm

-ϕ 10mm steel reinforcement used for vertical steel reinforcement.

-d=540mm



Solution

Tu<0.083Φ√ f`c (A^2cp / Pcp)

ACP=750*150+450*300=247500 mm^2

PCP=750+600+300+450+450+150=270

0mm

0.083*0.75√ 28 (247500^2 / 2700) =7.47*10^6 N.mm=7.47kN.m

Tu=38< 7.47 Need Torsion Design

=Check equation %

X_o=300-

2*40*10=210mm

Y_o=600-

2*40*10=510mm

Aoh=210*510=107100

Ph=2(X_o+ Y_o) =2(210+510) =1440mm

$$□□ = \frac{1}{6}\sqrt{□`□} * □□ * □$$

$$□□ = \frac{1}{6}\sqrt{28} * 300 * 540 = 142.87□□$$

$$\sqrt{\left(\frac{156 * 10^3}{300 * 540}\right)^2 + \left(\frac{38 * 10^6 * 1440}{1.7 * 107100^2}\right)^2} \le 0.75\left(\frac{142.87 * 10^3}{300 * 540} + 0.66 * \sqrt{28}\right)$$

2.97 < 3.28 O.K.

Vu > ϕVc

156 > 0.75*142.87=107.15 Need stirrups for shear

$$□□ = \frac{\frac{□}{□}}{\phi} - □□$$

$$\frac{156}{0.75} - 142.87 = 65.13$$

=

$$\sqrt{\left[\frac{Vu}{bw\ d}\right]^2 + \left[\frac{Tu\ ph}{1.7\ Aoh^2}\right]^2} \leq \emptyset\left(\frac{Vc}{bw\ d} + 0.66\sqrt{f`c}\right)$$

$\square\square = \frac{\square\square * \square}{\square\square * \square}$

$\square\square = \frac{65.13 * 10^3 * \square}{414 * 540} = 0.29\square$

$\square\square = \frac{2 * \square_\square * \square\square * \square\square\square}{\square\square\square\phi\ \square}$

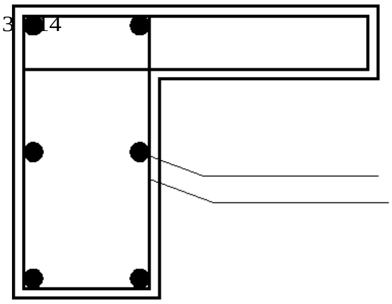
A_o=0.85*Aoh=0.85*107100=91035mm^2

$\frac{38 * 10^6}{0.75} = \frac{2 * 91035 * \square\square * 414}{\square}$

At=0.67*S

Av+2*At=0.29S+2*0.67S=1.63 $\frac{1}{3}\frac{\square\square * \square}{300* \square\ \square\square} = \frac{1}{3}\frac{}{414} = 0.24\square$

S >



For ϕ 10mm

2A=2*78.5=157mm^2 157=1.63

S

S=96.3mm

S_{max}=ph/8=1440/8=180

mm S_{max}=300mm

Use ϕ 10mm @95mm c/c

$\square\square = \frac{\square\square}{\square}\ \square h\frac{\square\square\square}{\square\square\square}\ \square\square\square\phi^2 = 0.67 * 1440 = 964.8\ \square\square^2$

$\square\square\square\square\square = 0.42\sqrt{\square}\ \frac{\square\square\square\square}{\square\square} - \frac{\square\square}{\square}\ \square h\frac{\square\square\square}{\square\square\square}$

$\frac{\square\square}{\square} \geq 0.175\ \frac{\square\square}{\square\square\square}$

$\frac{\square\square}{\square} = 0.67 \geq 0.175\ \frac{300}{414} = 0.13$

$\square\square\square\square\square = \frac{0\ 42\sqrt{28}}{.}$

247500
414

$- 0.67$
$*$
1440
$* \quad 1 =$
363.83
□□²

Extra notes: * ECTS Calculation

Erbil Technical Engineering College									
Program: Bachelor (240 ECTS)									
Department name:		Technical Civil Engineering Dept.							
#		**15-20**							
(Min. 12 weeks active lecturing (Including Mid Term exams with no stopping of lectures) + 3 weeks Final & Re-sit Exams									
Lecturer Name:		Asst. Prof. Dr. Bahman Omar Taha					**1.0 ECTS =**	**27**	working hours
Module Name:		Reinforced Concrete Structures					X	Y	Z
Module Code:		RCS702					4	0	0
ECTS Workload Calculation Form									
Activity	S	Description		Activity	No.	T.F. Range		Time	Workload
						Min	Max		
Course	1	Theory	In class	f	12			4	48
	2		Online	f	0			4	0
	3	Preparation: (1-2)* X)		h	12	4	8	**6**	72
	4	Practical		f	0			0	0
	5	Preparation: (1-1.5)* Y		h	0	0	0	**2.5**	0
	6	Tutorial		f	0	1	1	0	0
	7	Preparation (0.5-1.5) * Z)		h	0	0	0	**1.5**	0
Site Visists and Lab Experiments	8	Scientific/Field Trips		f	0	2	6	4	0
	9	Practical/Lab Reports		h	0	1	2	1.5	0
Assignment	10	Homework		h	2	1	4	4	8
	11	Report		h		1	4		0
	12	Seminar		h	1	2	10	10	10
	13	Paper		h		4	15		0
	14	Essay		h		1	6		0
	15	Project/Poster		h	1	4	15	4	4
Assessment	16	Quiz		h	2	1	2	1	2
	17	Mid Term	Theory	f	1			1	1
	18		Preparation: (1.5-3)*X	h	1	6	12	**6**	6
	19		Practical	f	0			1	0
	20		Preparation: (1-2)*Y	h	0	0	0	**3**	0
	21	Final	Theory	f	1			2	2
	22		Preparation: (3-5)*X	h	1	12	20	**12**	12
	23		Practical	f	0			1	0
	24		Preparation: (2-4)*Y	h	0	0	0	**5**	0
Face to face hours (f)/12			4.25	Face to face hours (f)					51

week			
Home hours (h)/15 week	7.60	Home hours (h)	114
Total hours/15 week	11.00	Total hours	165
ECTS (Total hours/ 27)			**6.111**

External Evaluator
External Evaluator
The course catalogue satisfies and adequate for the module Reinforced Concrete Structures RCS702.

Prof. Dr. Mereen Hassan Fahmi Rasheed