UC Berkeley
CE 123 – Fall 2017
Instructor: Alan Kren Name:_____

# CE 123 - Reinforced Concrete
## Mid-Term Examination No. 1

Instructions:

- Read these instructions. Do not turn the exam over until instructed to do so.
- Work all problems. Pace yourself so that you have time to work on each problem. Reasonable assumptions and approximations should be made where necessary.
- Show all relevant work. Credit will not be given for key elements of the solution that are not apparent.
- Partial credit will be given if procedures are outlined clearly.
- Work the solutions for each of the problems on separate sheets, working on one side of each sheet of paper. One problem solution may span more than one sheet. However, do not show the work for more than one problem on any given sheet. Staple the solution sheets to this cover sheet, problem 1 first, then problem 2, etc.
- If you have any questions, or need any paper or other materials, walk to the front of the classroom and ask the exam proctor. Do not raise your hand to get the proctor's attention, and do not call out questions from your seat.
- Neatness is expected and counts 10% of your grade. Therefore, write neatly and organize your solutions to make checking as easy as possible.
- Unless otherwise stated, all problems use the ACI 318-2011 strength design method, and all concrete is normal weight.
- When instructed, read the entire exam. Do not begin working out the solutions, rather, think about the problems and how you will solve them. You will have 5 minutes to think about the problems and to organize your thoughts.
- When instructed, begin working the problems.

| | Possible Points | | Score |
|---|---|---|---|
| Problem 1 | | 20 | _____ |
| Problem 2 | | 40 | _____ |
| Problem 3 | | 40 | _____ |
| TOTAL | 100 | | _____ |

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Problem 1.

A partial framing plan is shown on the following sheet showing the layout of the beams, girders, and columns that frame a building. A one-way concrete slab, is supported by the beams and girders. While the plan shows only one edge of the building, assume that column spacing and framing continues for several bays in each direction. Slab, beam, girder, and column dimensions are shown on the plan.

The slab supports the following uniformly distributed loads (i.e. the loads are uniformly distributed over the entire top of the slab):

| Uniformly Distributed Loads | | |
|---|---|---|
| Dead Loads | | Weight PSF |
| | Flooring, ceiling, lights | 5 |
| | Mechanical, electrical, plumbing | 15 |
| Sum Dead Load | | |
| | | |
| Live Loads | | |
| | Partitions | 15 |
| | Laboratory equipment | 50 |
| | All other | 80 |
| Sum Live Load | | |

a. Draw an arrow on the framing plan indicating the direction the slab spans.
b. Fill out the table above summing dead and live loads:
c. What is the self-weight of the slab?
d. What is the uniform dead load, $w_D$ that the slab supports?
e. What is the uniform live load, $w_L$, that the slab supports?
f. What is the self-weight of the beam that is additional to that portion of the beam that is also a portion of the slab?
g. What is the factored uniform dead load, $w_{uD}$, to the beam, when combined with live load?
h. What is the factored uniform live load $w_{uL}$ to the beam?
i. What is the factored dead load, $P_{uD,}$ to the girder, when combined with live load?
j. What is the factored live load, $P_{uLl}$, to the girder?

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Problem 2.

A 36”x48” beam is drawn in section on the following page in elevation and in section. Relevant design parameters are shown on section drawing.

For this beam:

a. What is the concrete modulus of rupture, $f_r$?
b. What is the concrete modulus of elasticity, $E_c$?
c. What is the steel modulus of elasticity, $E_s$?
d. What is $B_1$?
e. What is $b_w$?
f. What is the distance to the centroid of the reinforcement d?
g. What area of reinforcement is provided?
h. What is the minimum amount of reinforcement that is permitted by the ACI code for this beam?
i. What is the maximum amount of reinforcement that is permitted by the ACI code for this beam?
j. Does the beam meet code requirements for minimum and maximum area of reinforcement?
k. What is the clear spacing between flexural reinforcement bars?
l. What is the minimum spacing of the flexural reinforcement permitted by the ACI code?
m. Does the flexural reinforcement placement meet minimum spacing permitted by the ACI code?
n. What is the center to center spacing between flexural reinforcement bars?
o. What is $C_c$ to the bottom layer of reinforcement?
p. What is the maximum spacing of the flexural reinforcement permitted by the ACI code?
q. Does the flexural reinforcement placement meet maximum spacing permitted by the ACI code.
r. Does the beam require side (skin) reinforcement per the ACI code and why or why not?
s. What is the maximum spacing of skin reinforcement if it is required.

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Problem 3
A concrete beam that is exactly the same size as that shown in problem 1 is illustrated on the attached sheet. Concrete compressive strength, $f'_c$, and reinforcement yield strength, $f_y$, are also the same as in problem 2. There are (12) #10 bars, $A_s$=15.24" and d=43". The beam spans 52'-0" between support points as a pin/pin beam.

For this beam:

a. What is the minimum height, h, permitted by ACI code with calculation, if nothing that might be damaged by deflections is attached to the beam?
b. What is the beam's nominal moment capacity $M_n$?
c. What is the distance to the centroid, C, if the beam is bending to its nominal moment strength, $M_n$?
d. What is the assumed strain in the concrete if the beam is bending to its nominal moment strength, $M_n$?
e. What is the reinforcement strain $E_s$ if the beam is bending to its nominal moment strength, $M_n$?
f. What is the appropriate φ factor to use when comparing the nominal moment capacity $\varphi M_n$ to the factored moment demand $M_u$?
g. What is the beam's weight per linear foot? Provide your answer in kips/foot.
h. What is the equation for the maximum moment in a beam that is supporting a uniform load and where does this load occur?
i. What is the equation for the maximum moment in a beam that is supporting a point load centered on the beam span and where does this load occur?
j. If the reinforcement were changed such that $\varphi M_n$ = 4030 kip feet, and the beam supported an unfactored uniform dead load $w_D$ = 3.0 kips/foot and an unfactored fixed live load $P_L$ = 100 kip at the beam's center span ***(the live load cannot move)***, what additional unfactored uniform live load $w_L$ does the beam have the strength to support? Draw the beam with the loads and the span length noted to solve the moment demand on the beam.
k. If the beam were required to support a factored moment $M_u$ of 5000 kip feet what area of reinforcement would be required? **Assume φ = 0.9. Do not check Es.**