ARCH 631. Formulas of Exam 2
from Lectures, Examples, and Assignments

$\sum F_x = 0$	$\sum F_y = 0$	$\sum M = 0$
$V = \int -wdx$	$M = \int Vdx$	$M = Fd$
area of a rectangle $= b \times h$	area of a triangle $= \frac{b \times h}{2}$	area of a trapezoid $= b \times \frac{(h_1 + h_2)}{2}$
fixed base portal frame with assumed inflection points and lateral load: $R_{1x} = R_{2x} = P/2$; $R_{1y} = -0.45\,Ph/L$; $R_{2y} = 0.45\,Ph/L$; $M_1 = M_2 = 0.275Ph$; $M_{joints} = 0.225Ph$	$f_{max} = \frac{P}{A} + \frac{Mc}{I} = \frac{P}{A} + \frac{M}{S}$	three span beam with integral end supports: $V_{max} = 1.15\,wL/2$; $M_{max+ends} = wL^2/14$; $M_{max+interior} = wL^2/16$; $M_{max-column} = wL^2/16$; $M_{max\text{-ends,other support}} = wL^2/10$; $M_{max\text{-interior}} = wL^2/11$
	$w = \gamma A$	
	simply supported at corners square plate $m_{max} = 0.15w'a^2$	
	2. $1.2D + 1.6L$	
$M = Td$	slab depth = $L/$number or $\ell_n/$number	

$\ell_n = \ell - \frac{1}{2}$ support 1 width $- \frac{1}{2}$ support 2 width	$m = M/$strip width	$M_o = (M_T) = \frac{w_u \ell_2 \ell_n^2}{8}$
flat slab, interior bay, COLUMN strip: $M_{negative} = (0.75 \cdot 0.65 M_T) = 0.49 M_o$; $M_{positive} = (0.60 \cdot 0.35 M_T) = 0.21 M_o$; flat slab, interior bay, MIDDLE strip: $M_{negative} = (0.25 \cdot 0.65 M_T) = 0.16 M_o$; $M_{positive} = (0.40 \cdot 0.35 M_T) = 0.14 M_o$	fully fixed square plate $m_{negative} = 0.0513w'a^2$	$\phi M_n = \phi A_s f_y \left(d - a/2\right)$ $\phi = 0.9$ *
	$a = \frac{A_s f_y}{0.85 f'_c b}$	to determine maximum steel for 0.005 strain $c = 0.375d$, $a = \beta_1 c$
	$M_{max(case\,1)} = \frac{wl^2}{8}$	$R_n = \frac{M_n}{bd^2}$ or $\frac{M_u}{\phi bd^2}$
	$\rho = \frac{A_s}{bd}$	$V_{x(case\,1)} = wl/2 - wx$

beam: $A_{s-min} = \frac{3\sqrt{f'_c}}{f_y}(b_w d)$ not less than $\frac{200}{f_y}(b_w d)$	$\phi V_c = \phi 2\lambda\sqrt{f'_c} b_w d$ $\lambda = 1.0$ normal weight
$\phi V_c \geq V_u > \phi V_c/2$: $s_{required} =$ smaller of $\frac{A_v f_{yt}}{50 b_w}$ and $\frac{A_v f_{yt}}{0.75\sqrt{f'_c}\, b_w}$	$V_u \leq \phi V_c + \phi V_s$ $\phi = 0.75$

$V_u > \phi V_c$: $s_{required} = \frac{\phi A_v f_{yt} d}{V_u - \phi V_c}$ or $\frac{\phi A_v f_{yt} d}{\phi V_s}$	$P = f \cdot A$	sphere: $T = p_r R/2$
$N_\phi = \frac{Rw}{1 + \cos\phi}$	$T = N_\phi \cos\phi a$	cylinder: $T = p_r R$

$N_\theta = Rw\left(-\frac{1}{1 + \cos\phi} + \cos\phi\right)$	$a = R\sin\phi$	$w = \gamma t$	$f = T/t$
single overhang at 0.292L: $M = 0.043wL^2$	double overhangs at 0.21L: $M = 0.021wL^2$	$f_\phi = N_\phi/t$	$f_\theta = N_\theta/t$

$P_o = 0.85f'_c(A_g - A_{st}) + f_y A_{st}$	$L_{LL} = L_o(0.25 + \frac{15}{\sqrt{K_{LL}A_T}})$	slabs: $A_{s\text{-}min} = 0.002bt$ (40 or 50 grade) $A_{s\text{-}min} = 0.0018bt$ (60 grade)
tied: $\phi_c P_n = \phi_c(0.8P_o)$ $\phi_c = 0.65$	$V_{u2} = w_u$(tributary area $- b_1 \times b_2$)	$V_{u2} \le \phi\left(2 + \frac{4}{\beta_c}\right)\lambda\sqrt{f'_c}b_o d \le \phi 4\lambda\sqrt{f'_c}b_o d$
spiral: $\phi_c P_n = \phi_c(0.85P_o)$ $\phi_c = 0.75$	$b_E = min(\frac{\ell_n}{4}, b_w + 16t$, or center-center spacing)	$b_o = 2(b_1)+2(b_2)$
$E_c = 57{,}000\sqrt{f'_c}$ normal weight		