Q1: Determine the service moment capacity for a rectangular beam section that has a width of 350mm and a depth of 500mm and reinforced with top bars of 5Ф25, using the allowable strength method. The concrete compressive strength, $f'_c= 32$ MPa and the steel yield strength, $f_y= 400$ MPa.

Q2: A rectangular beam section of 400mm width and 600mm depth ($d= 540$mm) and reinforced with bottom bars of 6Ф20 is to be converted to a beam of 400mm depth ($d= 350$mm). Determine the needed beam width and reinforcement using the same steel ratio. The concrete compressive strength, $f'_c= 32$ MPa and the steel yield strength, $f_y= 420$ MPa.

Q3: A beam section of 350mm width is to be designed to resist a moment of 400kN.m. The concrete compressive strength, $f'_c= 24$ MPa and the steel yield strength, $f_y= 420$ MPa. Determine the needed section depth and reinforcement using steel ratio varies from $\rho= 0.003$ to $\rho= 0.015$ considering steps of 0.001. Determine the concrete volume and the steel weight for each steel ratio considering one meter length of beam. If the concrete cost is 320 INS/m³ and the steel cost is 3200 INS/ton, calculate the cost for the design for each steel ratio. Make comments.

Q4: A. Derive a formula for the maximum steel ratio allowed by the code (ACI 318-08) to have singly reinforced concrete rectangular beam section and calculate the corresponding steel reduction factor, $\Phi$. (In ACI 318-08, the maximum allowed strain in tensile steel is 0.004). Determine the design moment capacity for a rectangular beam section of 450mm width and 600mm depth ($d= 540$mm) that have this steel ratio. The concrete compressive strength, $f'_c= 28$ MPa and the steel yield strength, $f_y= 420$ MPa.

B. Derive a formula for the steel ratio to have failure in concrete and yielding of steel bars at the same time for a steel have yield strength, $f_y$ for a rectangular singly reinforced beam section. (This steel ratio is called balanced steel ratio)

Q5: Design a rectangular beam section that has a width equal to half the thickness for the beam shown in the figure below. $f'_c= 24$ MPa and the steel yield strength, $f_y= 420$MPa. Sketch the reinforcing layout of the beam. Assume maximum steel ratio, $\rho=0.012$