UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: October 2019

Module Number: CE5204 **Module Name: Structural Analysis III**

[Three Hours]

[Answer **all questions**, each question carries **TWELVE** marks]

Q1. The triangular slab shown in Figure Q1 is to serve as weather protection over a loading dock. It is simply supported along AB and BC, but AC is a free edge. The slab is reinforced for positive bending by an orthogonal grid providing resistance in all directions m= 10 kNm/m.

a) Discuss the advantages of yield line method in analyzing reinforced concrete slabs.

[2.0 Marks]

b) Assuming a possible yield line pattern, determine the collapse load 'q'.

[10.0 Marks]

Q2. A thin rectangular plate of side dimensions 'a', 'b' and thickness 'h' is simply supported along the four edges. It is subjected to a vertical downward load of intensity,
$p(x,y) = C \sin\frac{m\pi x}{a} \sin\frac{n\pi y}{b}$. The C is a constant and m, n are positive integers.

a) Show that the trial solution $w = w_0 \sin\frac{m\pi x}{a} \sin\frac{n\pi y}{b}$ satisfy the governing differential equation of thin plate when $w_0 = \frac{C}{\pi^4 D\left(\frac{m^2}{a^2}+\frac{n^2}{b^2}\right)^2}$ Here D is the flexural rigidity of the plate.

[4.0 Marks]

b) Verify that the above solution satisfies the relevant displacement and stress boundary conditions.

[4.0 Marks]

c) The plate was subjected to a load of 250kPa (C=250kPa), when m=3, n=2, a=1m and b= 3m. The thickness of the plate is 10mm. Modulus of elasticity and Poisson's ratio was given as 200GPa and 0.3 respectively. Determine the maximum displacement of plate under above conditions. [4.0 Marks]

Q3. a) What are the conditions that need to be satisfied in an axisymmetric plate?

[2.0 Marks]

b) A thin circular plate of radius a, thickness t, Young's modulus E and poisons ratio v is simply supported at the edges. Obtain an expression for the deflection w, when this plate is subjected to a uniformly distributed vertical downward load of p_0.

[6.0 Marks]

c) If this plate is rotated in horizontal plane by an angle $\theta_0 = \lambda p_0$, obtain an expression for λ.

[4.0 Marks]

Q4.

a) Discuss the advantages of shell as a structural form.

[2.0 Marks]

b) A thin spherical dome is subjected to a uniformly distributed load of p over plan area as shown in Figure Q4. Determine the membrane stress resultant in the structure.

Following relationships may be assumed for spherical shells under axisymmetric loading with usual notations and sign convention.

$$P_\varphi r_1 r - r_1 N_\theta Cos\ \varphi + \frac{\partial(rN_\varphi)}{\partial\varphi} = 0 \qquad P_r = \frac{N_\varphi}{r_1} + \frac{N_\theta}{r_2}$$

[10.0 Marks]

Q5.

a) Show that the membrane stresses in a conical shell *(with usual notations and sign convention)* are given by

$$N_\theta = P_r S \tan\alpha \qquad S N_S = \left(\int P_r S \tan\alpha - P_s S\right) dS$$

[6.0 Marks]

You may use the relationships given in Q4 if needed.

b) A conical shell stiffened by two rings at upper and lower levels is shown in Figure Q5. The shell structure is carrying a vertical line load of P per unit length and self-weight w per unit surface area. Using the membrane stresses obtained in Part (a), determine the membranes stresses caused due to loading.

[6.0 Marks]

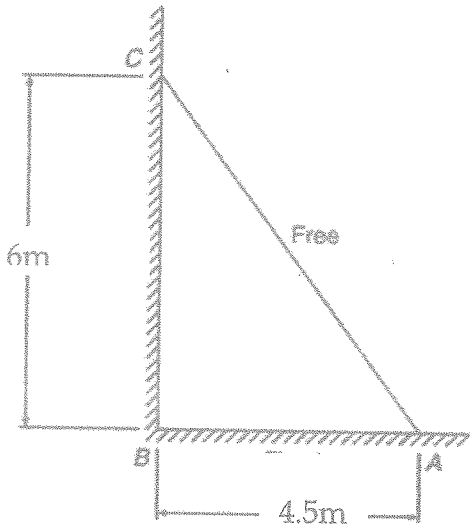

Figure Q 1

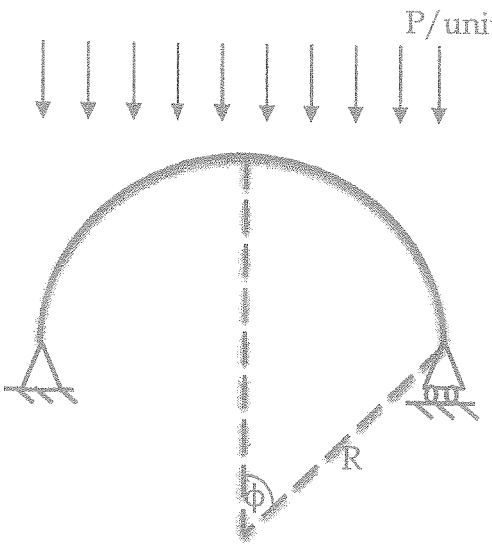

Figure Q 4

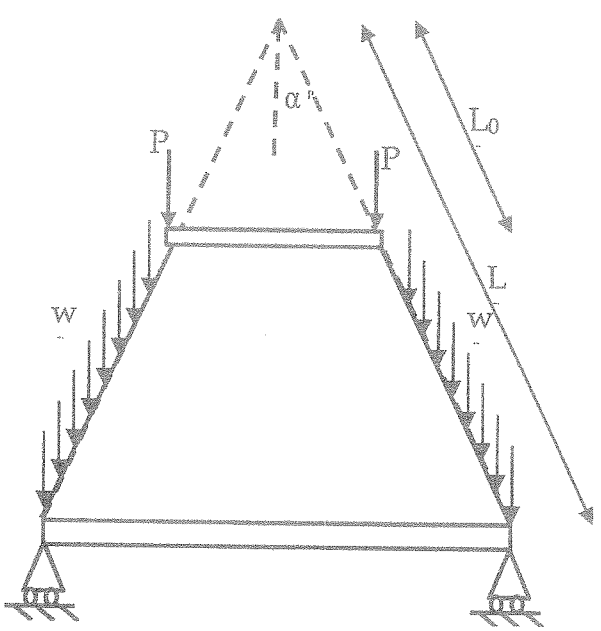

Figure Q 5