
UNIVERSITI SAINS MALAYSIA

1st. Semester Examination
2004/2005 Academic Session

October 2004

EAS 661/4 – Advanced Structural Mechanics

Time : 3 hours

Instruction to candidates:

1. Ensure that this paper contains **EIGHT (8)** printed pages before you start your examination.
2. This paper contains **FIVE (5)** questions. Answer **ALL (5)** questions.
3. All questions carry the same mark.
4. All questions **MUST BE** answered in English.
5. Each question **MUST BE** answered on a new sheet.
6. Write the answered question numbers on the cover sheet of the answer script.

1. (a) Three dimensional continua problem could be specialized to two well-known cases of plane stress and plane strain problems. Explain clearly with the help of suitable sketches the difference between plane stress and plane strain problems.

(6 marks)

- (b) Figure 1.0 shows the stress components acting on an infinitesimal volume in a three dimensional body. Using the notation of :

$$\sigma = [\sigma_x \ \sigma_y \ \sigma_z \ \tau_{xy} \ \tau_{yz} \ \tau_{zx}]^T$$

and

$$\epsilon = [\epsilon_x \ \epsilon_y \ \epsilon_z \ \gamma_{xy} \ \gamma_{yz} \ \gamma_{zx}]^T$$

for the Cartesian components of stress and the corresponding strain, respectively, derive the constitutive equation $\epsilon = D\sigma$ for the case of a homogeneous isotropic body. Specialize it to the case of a plane stress problem.

(8 marks)

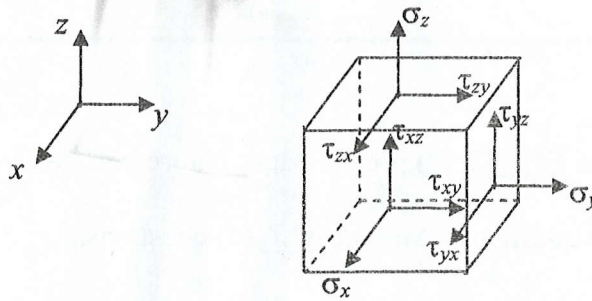


Figure 1.0

- (c) The sets of equilibrium equations and strain-displacement equations for an infinitesimal volume in a three dimensional body as shown in Figure 1.0 are given as follows, respectively :

Equilibrium equations :

$$\frac{\partial \sigma_x}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{zx}}{\partial z} + R_x = 0$$

$$\frac{\partial \sigma_y}{\partial y} + \frac{\partial \tau_{yz}}{\partial z} + \frac{\partial \tau_{xy}}{\partial x} + R_y = 0$$

$$\frac{\partial \sigma_z}{\partial z} + \frac{\partial \tau_{zx}}{\partial x} + \frac{\partial \tau_{yz}}{\partial y} + R_z = 0$$

where R_x , R_y and R_z are body forces per unit volume in x , y and z -directions, respectively;

Strain-displacement equations :

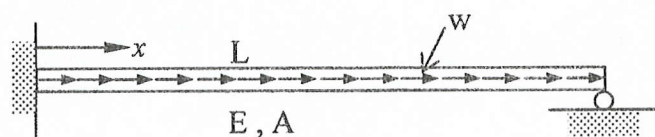
$$\epsilon_x = \frac{\partial u}{\partial x} , \quad \epsilon_y = \frac{\partial v}{\partial y} , \quad \epsilon_z = \frac{\partial w}{\partial z}$$

$$\gamma_{xy} = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} , \quad \gamma_{yz} = \frac{\partial v}{\partial z} + \frac{\partial w}{\partial y} , \quad \gamma_{zx} = \frac{\partial w}{\partial x} + \frac{\partial u}{\partial z}$$

where u , v and w are components of displacement in x , y and z -directions, respectively, of a point within the three dimensional body.

Using the above sets of equations together with the general constitutive equations for a homogeneous isotropic body derived in (b) earlier, specialize them to the case of a 1D bar loaded with uniformly distributed body force as shown in Figure 2.0. Explain clearly all assumptions made in the process of specialization. State also the boundary condition for the problem.

(6 marks)



E, A : constant

Figure 2.0