1. Consider the case that the displacement u and v can be expressed in Cartesian coordinate as

   $u=a+by \qquad v=c-bx$

   where a , b and c are constants.

   (a) Find the strain components (5%)

   (b) Explain the physical meanings of a , b and c respectively (10%)

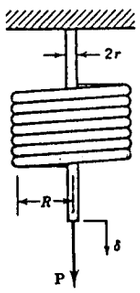
2. Discuss the assumptions made in the following field equations

   (a) Equilibrium equation $\frac{\partial\sigma_{xx}}{\partial x}+\frac{\partial\sigma_{xy}}{\partial y}+\frac{\partial\sigma_{xz}}{\partial z}+F_x=0$ etc. (5%)

   (b) Strain displacement relation $\varepsilon_x=\frac{\partial u}{\partial x}$ etc , $\gamma_{xy}=\frac{\partial u}{\partial y}+\frac{\partial v}{\partial x}$ etc (5%)

   (c) Hooke's Law $\varepsilon_x=\frac{1}{E}[\,\sigma_{xx}-\nu\,(\sigma_{yy}+\sigma_{zz})]$ etc , $\gamma_{xy}=\frac{\tau_{xy}}{G}$ etc (5%)

3. Consider a closely wound coil spring of radius R loaded by a force P. The spring consists of n turns of wire radius r. Find the deflection of the spring and hence the spring constant. (15%)



4. Determine the reactions at the supports A of the beams as shown in Fig(4a) and Fig(4b). (10%)

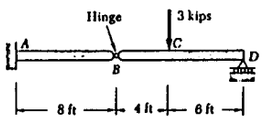


Fig (4a)

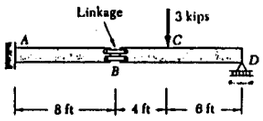
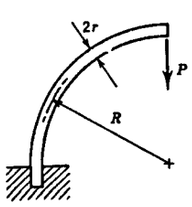


Fig (4b)

5. An elastic wire of radius r has the form of a quarter circle of radius R. Obtain the deflection δ in the direction of the load P , taking into account bending and axial loading. Show that the ratio of the axial contribution to the bending contribution is (15%)

$$\frac{\delta_a}{\delta_b}=\frac{1}{4}\frac{r^2}{R^2}$$



6. A closed system undergoes a cycle

(a) Is it possible for there to be a net transfer of work if there is no transfer of heat ? (2%)

(b) Is it possible for there to be a net transfer of heat if there is no transfer of work ? (2%)

(c) If the net work transfer is zero, does this mean that there is no heat transfer ? (3%)

(d) If the net transfer of heat is zero, does this mean that there is no work transfer ? (3%)

7. If a gas obeys the equation of state

$$P = \frac{RT}{v-b} - \frac{a}{v^2} \quad \text{(Van Der Waals Equation)}$$

(a) State the physical meaning of the constant b and the term a/v^2. (5%)

(b) Draw the isothermal line in the P-V diagram. (5%)

(c) Show that

$$T(v-b)^{R/C_v} = \text{constant} \qquad (10\%)$$

when the gas undergoing a reversible adiabatic process.

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