Indian Institute of Science
ME 242: Midsemester Test

Date: 3/11/12.
Duration: 2.30 p.m.–3.30 p.m.
Maximum Marks: 10

1. A semi-infinite wedge is subjected to a uniform pressure load q on one of its edges as shown in Fig. 1. Assuming the Airy stress function to be of the form

$$\phi = r^2 f(\theta),$$

find the governing equation for $f(\theta)$, and solve this equation (Hint: Substituting $d^2f/d\theta^2 = g(\theta)$ may help.). State the equations for determining the unknown constants (you need not solve these equations). By considering the tractions on the surface $r = r_0$, and *without actually carrying out the integration*, find $\int_0^\alpha \tau_{r\theta}|_{r=r_0}\, d\theta$. The relevant formulae are

$$\begin{aligned}
\boldsymbol{\nabla}^4\phi &= 0,\\
\boldsymbol{\nabla}^2 &\equiv \frac{\partial^2}{\partial r^2} + \frac{1}{r}\frac{\partial}{\partial r} + \frac{1}{r^2}\frac{\partial^2}{\partial \theta^2},\\
\tau_{rr} &= \frac{1}{r}\frac{\partial \phi}{\partial r} + \frac{1}{r^2}\frac{\partial^2 \phi}{\partial \theta^2},\\
\tau_{\theta\theta} &= \frac{\partial^2 \phi}{\partial r^2},\\
\tau_{r\theta} &= -\frac{\partial}{\partial r}\left(\frac{1}{r}\frac{\partial \phi}{\partial \theta}\right).
\end{aligned}$$

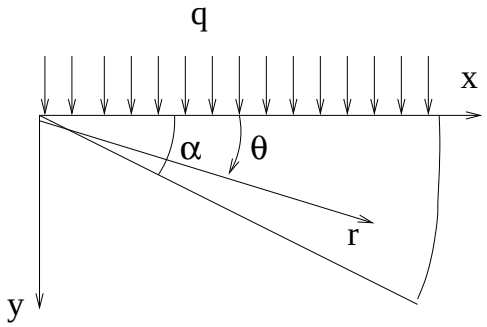

Figure 1: Wedge subjected to a uniform pressure load q.