18. By definition, \[ P_2(\cos \phi) = \frac{3}{2} \cos^2 \phi - \frac{1}{2}. \]

Hence
\[ 1 - \cos^2 \phi = -\frac{3}{2} P_2(\cos \phi) + \frac{3}{2}, \]

and
\[ \mu = -\frac{3}{2} r^2 P_2(\cos \phi) + \frac{3}{2} \]
\[ = r^2 (\cos^2 \phi) + \frac{3}{2} + \frac{3}{2}. \]

Solutions to Problem Set 12.11, page 598

4. \( w = w(x, \tau), W = \mathcal{L}\{w(x, \tau)\} = W(x, s) \). The subsidiary equation is
\[ \frac{\partial W}{\partial \tau} + x\mathcal{L}\{w_x(x, \tau)\} = \frac{\partial W}{\partial x} + x(sW - w(x, 0)) = x\mathcal{L}(1) = \frac{x}{s} \]
and \( w(x, 0) = 1 \).

By simplification,
\[ \frac{\partial W}{\partial \tau} + xW = x + \frac{x}{s}. \]

By integration of this first-order ODE with respect to \( x \) we obtain
\[ W = c(s)e^{-x^2/2} + \frac{1}{s^2} + \frac{1}{s}. \]

For \( x = 0 \) we have \( w(0, \tau) = 1 \) and
\[ W(0, s) = \mathcal{L}\{w(0, \tau)\} = \mathcal{L}\{1\} = \frac{1}{s} = c(s) + \frac{1}{s^2} + \frac{1}{s}. \]

Hence \( c(s) = -1/s^2 \), so that
\[ W = -\frac{1}{s^2} e^{-x^2/2} + \frac{1}{s^2} + \frac{1}{s}. \]

The inverse Laplace transform of this solution of the subsidiary equation is
\[ w(x, \tau) = -(t - \frac{1}{2} x^2) u(t - \frac{1}{2} x^2) + t + 1 \]
\[ = \begin{cases} t + 1 & \text{if } t < \frac{1}{2} x^2 \\ \frac{3}{2} x^2 + 1 & \text{if } t > \frac{1}{2} x^2. \end{cases} \]