LeGendre solutions

Show that the first three LeGendre polynomials are solutions for the equation:

$$(1 - x^2)\frac{\partial^2 P(x)}{\partial x^2} - 2x\frac{\partial P(x)}{\partial x} + \left(J(J + 1) - \frac{M^2}{1 - x^2}\right)P(x) = 0$$

You may assume the case of M = 0.

$$(1 - x^2)\frac{\partial^2 P(x)}{\partial x^2} - 2x\frac{\partial P(x)}{\partial x} + J(J + 1)P(x) = 0$$

Legendre Polynomials

P0(x)=1 P_1(x)=x P_2(x)=1/2 (3x2 - 1) P_3(x)=1/2 (5x3 - 3x)