# A NOTE ABOUT THE DERIVATIVES OF LEGENDRE POLYNOMIALS

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Here is an alternative, shorter, proof of the result proved by Grosswald.[1]

We have

$$(1 - 2x\rho + \rho^2)^{-1/2} = \sum_0^\infty P_n(x)\rho^n.$$

Differentiating $r$ times with respect to $x$ and putting $x = 1$, we have

$$1 \cdot 3 \cdot s \cdots (2r - 1)\rho^r(1 - \rho)^{-2r-1} = \sum_0^\infty P_n^{(r)}(1)\,\rho^n.$$

Equating coefficients of $\rho^n$ we now have

$$P_n^{(r)}(1) = \frac{(n + r)!}{2^r r!(n - r)!}.$$

Similarly, we may show that

$$P_n^{(r)}(-1) = (-1)^{n+r}\frac{(n + r)!}{2^r r!(n - r)!}.$$

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[1] E. Grosswald, *On a simple property of Legendre's polynomials*, Proceedings of the American Mathematical Society vol. 1 (1950) pp. 553–554.