

## MA 523: Homework 6

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**PROBLEM 6.1**

For  $n = 2$  find Green's function for the quadrant  $\{x_1 > 0, x_2 > 0\}$  by repeated reflection.

*Solution.*

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**PROBLEM 6.2**

(Precise form of Harnack's inequality) Use Poisson's formula for the ball to prove

$$\frac{r^{n-2}(r-|x|)}{(r+|x|)^{n-1}}u(0) \leq u(x) \leq \frac{r^{n-2}(r+|x|)}{(r-|x|)^{n-1}}u(0)$$

whenever  $u$  is positive and harmonic in  $B(0, r) = \{x \in \mathbb{R}^n : |x| < r\}$ .

*Solution.*

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**PROBLEM 6.3**

Let  $P_k(x)$  and  $P_m(x)$  be homogeneous harmonic polynomials in  $\mathbb{R}^n$  of degrees  $k$  and  $m$  respectively; i.e.,

$$\begin{aligned} P_k(\lambda x) &= \lambda^k P_k(x), & P_m(\lambda x) &= \lambda^m P_m(x) & \text{for every } x \in \mathbb{R}^n, \lambda > 0, \\ \Delta P_k &= 0, & \Delta P_m &= 0 & \text{in } \mathbb{R}^n. \end{aligned}$$

(a) Show that

$$\frac{\partial P_k}{\partial \nu} = k P_k(x), \quad \frac{\partial P_m}{\partial \nu} = m P_m(x) \quad \text{on } \partial B(0, 1)$$

where  $B(0, 1) = \{x \in \mathbb{R}^n : |x| < 1\}$  and  $\nu$  is the outward normal on  $\partial B(0, 1)$ .

(b) Use (a) and Green's formula to prove that

$$\int_{\partial B(0, 1)} P_k(x) P_m(x) d\sigma = 0, \quad \text{if } k \neq m.$$

*Solution.*

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