OPTI 535 Final Exam December 12, 2007

1. The Munnerlyn formula describes the shape of the post-LASIK cornea. Over the central optical zone, the cornea can be approximated as a sphere of radius R1. Outside the optical zone, the cornea is a sphere of radius R2. For R1 = 8 mm, R2 = 7.8 mm and an optical zone diameter of 6 mm, the sag of the cornea is given by

$$f(r) = \begin{cases} 8 - \sqrt{8^2 - r^2} & \text{for } r < 3.0\text{ mm} \\ 7.8 - \sqrt{7.8^2 - r^2} + C & \text{for } r \geq 3.0\text{ mm} \end{cases}$$

(a) Find the constant C such that the cornea is continuous at r = 3 mm.

(b) What is the axial power of the cornea as a function of r? Assume $n_k = 1.3375$.

(c) What is the instanteous power of the cornea as a function of r?

(d) Plot the results of parts b and c

2. Alvarez's student William Humphrey patented a variable power cylinder lens similar to his mentor's variable power spherical lens. One form of these lenses is given by

$$t = A\left[\frac{x^3}{3} - xy^2\right] + Cxy$$

Represent this surface as a set of Zernike polynomials. (You can assume x and y are normalized coordinates.

3. The local planetarium is showing a Laser Floyd show. The have three lasers to create the special effects. The wavelengths of these lasers are 480 nm, 540 nm and 630 nm and each laser has the same maximum power.

(a) What are the chromaticity coordinates of each laser?

(b) The three laser spots are overlapped to create a new color. If the blue laser puts out 1 Watt, what powers do the red and green lasers need to put out to create a white spot? Assume the equal energy white ($x_w = 0.33$, $y_w = 0.33$).

λ	White	Color	IllumC	xbar	ybar	zbar
380	0.153	0.118	31.3	0.001368	0.000039	0.006450001
390	0.245	0.179	45	0.004243	0.00012	0.02005001
400	0.409	0.283	60.1	0.01431	0.000396	0.06785001
410	0.671	0.343	76.5	0.04351	0.00121	0.2074
420	0.84	0.359	93.2	0.13438	0.004	0.6456
430	0.878	0.35	106.7	0.2839	0.0116	1.3856
440	0.883	0.327	115.4	0.34828	0.023	1.74706
450	0.886	0.298	117.8	0.3362	0.038	1.77211
460	0.887	0.267	116.9	0.2908	0.06	1.6692
470	0.888	0.239	117.6	0.19536	0.09098	1.28764
480	0.888	0.209	117.7	0.09564	0.13902	0.8129501
490	0.888	0.182	114.6	0.03201	0.20802	0.46518
500	0.887	0.163	106.5	0.0049	0.323	0.272
510	0.887	0.146	97.2	0.0093	0.503	0.1582
520	0.887	0.124	92	0.06327	0.71	0.07824999
530	0.887	0.106	93.1	0.1655	0.862	0.04216
540	0.887	0.102	97	0.2904	0.954	0.0203
550	0.886	0.107	99.9	0.4334499	0.9949501	0.008749999
560	0.887	0.106	100	0.5945	0.995	0.0039
570	0.888	0.112	97.2	0.7621	0.952	0.0021
580	0.887	0.141	92.9	0.9163	0.87	0.001650001
590	0.886	0.198	88.5	1.0263	0.757	0.0011
600	0.887	0.279	85.2	1.0622	0.631	0.0008
610	0.889	0.394	84	1.0026	0.503	0.00034
620	0.891	0.522	83.7	0.8544499	0.381	0.00019
630	0.891	0.628	83.6	0.6424	0.265	5E-05
640	0.89	0.696	83.4	0.4479	0.175	0.00002
650	0.889	0.742	83.8	0.2835	0.107	0
660	0.889	0.766	83.5	0.1649	0.061	0
670	0.888	0.78	82	0.0874	0.032	0
680	0.888	0.791	79.8	0.04677	0.017	0
690	0.888	0.798	76.2	0.0227	0.00821	0
700	0.888	0.804	72.5	0.01135916	0.004102	0
710	0.886	0.807	68.8	0.005790346	0.002091	0
720	0.886	0.807	64.9	0.002899327	0.001047	0
730	0.885	0.813	61.2	0.001439971	0.00052	0
740	0.884	0.813	58.4	0.000690079	0.0002492	0
750	0.883	0.808	56.2	0.000332301	0.00012	0
760	0.882	0.814	55.2	0.000166151	0.00006	0
770	0.88	0.785	55.3	8.30753E-05	0.00003	0
780	0.879	0.752	55.3	4.15099E-05	0.00001499	0