國立中山大學102學年度碩士暨碩士專班招生考試試題

科目名稱：光電概論【材光系碩士班丙組】　　題號：439002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）　　

1. A device used to measure the radius of curvature of the cornea of the eye is called a keratometer (also known as a ophthalmometer), which is a diagnostic instrument for measuring the curvature of the anterior surface of the cornea, particularly for assessing the extent and axis of astigmatism. This is useful information when fitting contact lenses. In effect, an illuminated object is placed a known distance from the eye, and the image reflected off the cornea is observed. The instrument allows the operator to measure the size of the virtual image. If the magnification is found to be $0.035\times$ when the object distance is set at $100\,mm$, what is the radius of curvature? (10 %)

2. *A Bar at the Folies-Bergère* (Fig. 1), painted and exhibited at the Paris Salon in 1882, was the last major work by French painter ***Édouard Manet***. This paint shows a girl standing in front of a large planar mirror. Reflected in it is her back and a man in evening dress (on the right corner) with whom she appears to be talking. It would seem that ***Manet***'s intent was to give the uncanny feeling that the viewer is standing where the gentleman must be. From the laws of Geometrical Optics, what is wrong? (10 %)

Fig. 1

3. Two particles, each of mass m and having charge q, are suspended by very thin nonconducting strings of length l from a common point P. If the size of the particles is so small, compared to the separation. Find the angle θ that each string makes with the vertical. (10 %)

4. An electrophorus is a simple manual capacitive generator used to produce electrostatic charge via the process of electrostatic induction. One such instrument consists of a flat circular plate of wax and a similar plate of metal with an insulating handle. The wax plate is given a bound charge Q by rubbing it with fur. Then the metal plate is laid on the wax plate and temporarily grounded, so that it acquires a charge $-Q$. The metal plate is finally removed from the wax plate, retaining its charge $-Q$. Suppose the radius of the plates is $10\,cm$, $Q = 0.5\,\mu C$, and the initial separation of the two plates is $10^{-6}\,m$. Find the potential difference between the plates and the stored energy when the separation is

(a) $d = 10^{-6}\,m$, (10 %)

(b) $d = 0.02\,m$. (10 %)

5. Two particles, each of mass m and having charge q, are suspended by very thin nonconducting strings of length l from a common point P. If the size of the particles is so small, compared to the separation. Find the angle θ that each string makes with the vertical. (10 %)

6. Augustin Louis Cauchy (1789 – 1857) determined an empirical equation for the refractive index $n(\lambda)$ for substances that are transparent in the visible. His expression corresponded to the power series of wavelength

$$n(\lambda) = P_0 + \frac{P_2}{\lambda^2} + \frac{P_4}{\lambda^4} + \ldots$$

where the P_{2n} s are all constants. Later on, in 1871 Sellmeier derived the equation

$$n^2 = 1 + \sum_j \frac{A_j \lambda^2}{\lambda^2 - \lambda_{oj}^2}$$

where the A_j terms are constants and each λ_{oj} is the vacuum wavelength associated with a natural frequency ν_{oj}, such that $\lambda_{oj} \cdot \nu_{oj} = c$, where $c = 299{,}792{,}458\,{}^{\mathrm{m}}/_{\mathrm{S}}$ is the speed of light in vacuum. Sellmeier's formulation is a considerable practical improvement over the Cauchy equation mentioned above. Show that where $\lambda >> \lambda_{oj}$, Cauchy's Equation is an approximation of Sellmeier's. (10 %)

7. The following equations describe the plane waves propagating along the positive z-direction while the electric field ($\vec{E}$) varying in the xy plane. Express completely the state of polarization of each.

(a) $\vec{E} = E_0 \sin(kz - \omega t)\hat{x} + E_0 \sin(kz - \omega t)\hat{y}$ (5 %)

(b) $\vec{E} = E_0 \cos(kz - \omega t)\hat{x} + E_0 \cos\left(kz - \omega t + \frac{\pi}{2}\right)\hat{y}$ (5 %)

8. Fig. 2 show $4n$ point charges with equal charge q uniformly distributed on the circumference of a circle of radius R.

(a) Find the electric field on the specific point to the first order of δ. (i.e. consider δ is so small that the term $\left(\frac{\delta}{R}\right)^2$ and its higher terms may be neglected.) (10 %)

(b)Assuming the total charge $4nq$ is constant, simplify your answer for the limit $n \to \infty$ and $q \to 0$, and express it in terms of the ring's linear charge density. (10 %)

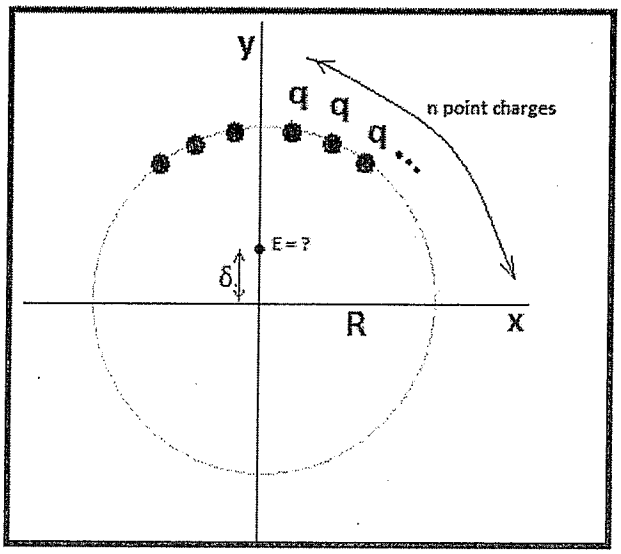

Fig. 2