MATLAB EXERCISE 1.23 **Electric potential due to a charged ring.** From Eq.(1.31) (in the book) and Fig.S1.5(a), the electric potential at an arbitrary point along the axis of a charged ring normal to its plane is given by

$$V = \frac{1}{4\pi\varepsilon_0}\oint_C \frac{Q'\,\mathrm{d}l}{R} = \frac{Q'}{4\pi\varepsilon_0 R}\oint_C \mathrm{d}l = \frac{Q'a}{2\varepsilon_0\sqrt{z^2+a^2}} \qquad (-\infty < z < \infty)\ . \tag{S1.9}$$

Using this expression, repeat MATLAB Exercise 1.9 but for the potential due to the ring, including a comparison with the potential due to the equivalent (for $|z| \gg a$) point charge. *(ME1_23.m on IR)*

SOLUTION:

For $|z| \gg a$, $z^2 + a^2 \approx z^2$, with which Eq.(S1.9) becomes

$$V \approx \frac{Q}{4\pi\varepsilon_0 z} \qquad (|z| \gg a)\ , \tag{S1.10}$$

where $Q = Q'2\pi a$ is the total charge of the ring.

The resulting graphical comparison of the expressions in Eqs.(S1.9) and (S1.10) using MATLAB is shown in Fig.S1.14.

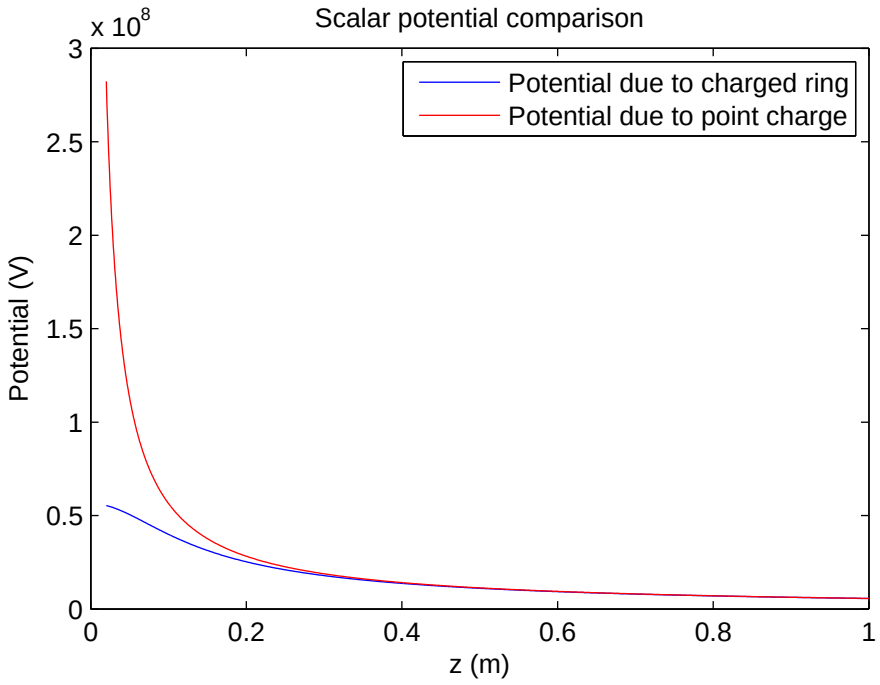

Figure S1.14 MATLAB comparison of electric potential along the z-axis due to a charged ring and the equivalent (for $|z| \gg a$) point charge, respectively, for $Q' = 1$ mC/m and $a = 10$ cm; for MATLAB Exercise 1.23.

```
%
%   Book: MATLAB-Based Electromagnetics (Pearson Prentice Hall)
%   Author: Branislav M. Notaros
%   Instructor Resources
%   (c) 2011
%
%   This MATLAB code or any part of it may be used only for
%   educational purposes associated with the book
%
%
%


%   Electric potential due to a charged ring


clear all;
close all;

Ql = input('Enter the uniform charge per unit length of the ring in C per meter: ');
a = input('Enter the ring radius in meters: ');
EPS0 = 8.8542*10^(-12);

dz = 0.01*a;
z = 20*dz:dz:10*a;
Qtot = Ql*2*pi*a;
Vz = Qtot./(4*pi*EPS0*sqrt(z.^2 + a^2));

% z>>a
V = Qtot./(4*pi*EPS0*z);

plot(z, Vz), hold on;
xlabel ('z (m)'), ylabel ('Potential (V)');
title ('Scalar potential comparison');
plot (z, V, 'r');
legend ('Potential due to charged ring','Potential due to point charge',1);
hold off;
```