MATLAB EXERCISE 2.9 **Symbolic Laplacian in different coordinate systems.** By symbolic programming in MATLAB, write functions `LaplaceCar()`, `LaplaceCyl()`, and `LaplaceSph()` that find Laplacian in the Cartesian, cylindrical, and spherical coordinate systems, respectively, based on Eqs.(2.8), (2.10), and (2.11) (from the book) (see MATLAB Exercise 1.33). Test the codes with $f_{\text{Cartesian}} = 3x^2y^3z$, $f_{\text{cylindrical}} = r^2\cos\phi\, z^3$, and $f_{\text{spherical}} = r^2\sin\theta\cos\phi$. *(LaplaceCar.m, LaplaceCyl.m, LaplaceSph.m, and ME2_9.m on IR)*

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

% This function computes div(grad(f)) in Cartesian coordinate system and
% returns symbolic expression

function F = LaplaceCar(f)
syms x y z

Fx = diff(f,x,2);
Fy = diff(f,y,2);
Fz = diff(f,z,2);
F = Fx + Fy + Fz;
```

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%  Symbolic Laplacian in cylindrical coordinates

% This function computes div(grad(f)) in Cylindrical coordinate system and
% returns symbolic expression

function F = LaplaceCyl(f)
syms r phi z

Fr = diff(r*diff(f,r),r);
Fp = diff(f,phi,2);
Fz = diff(f,z,2);
F = 1/r*Fr + 1/r^2*Fp + Fz;
```

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%     Symbolic Laplacian in spherical coordinates


% This function computes div(grad(f)) in Spherical coordinate system and
% returns symbolic expression

function F = LaplaceSph(f)
syms r phi theta

Fr = diff(r^2*diff(f,r),r);
Fp = diff(f,phi,2);
Ft = diff(sin(theta)*diff(f,theta),theta);
F = 1/r^2*Fr + 1/(r*sin(theta))^2*Fp + 1/(r^2*sin(theta))*Ft;
```

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clear all;
close all;

syms x y z;

f = 3*x^2*y^3*z;
F = LaplaceCar(f);
pretty(F);
```

```
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%

clear all;
close all;

syms r phi z;

f = r^2*cos(phi)*z^3;
F = LaplaceCyl(f);
pretty(F);
```

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%
%
%

clear all;
close all;

syms r phi theta;

f = r^2*cos(phi)*sin(theta);
F = LaplaceSph(f);
pretty(F);
```