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syms phi theta r f(r,theta,phi)

Df(1)=diff(f,r);
Df(2)=diff(f,theta);
Df(3)=diff(f,phi);


E(1,1)=cos(theta)*sin(phi); E(2,1)=sin(theta)*sin(phi); E(3,1)=cos(phi);

E(1,2)=-sin(theta); E(2,2)=cos(theta); E(3,2)=0;

E(1,3)=cos(theta)*cos(phi); E(2,3)=sin(theta)*cos(phi); E(3,3)=-sin(phi);


J(1,1)=cos(theta)*sin(phi); J(1,2)=sin(theta)*sin(phi); J(1,3)=cos(phi);

J(2,1)=-r*sin(phi)*sin(theta); J(2,2)=r*cos(theta)*sin(phi); J(2,3)=0;

J(3,1)=r*cos(theta)*cos(phi); J(3,2)=r*sin(theta)*cos(phi); J(3,3)=-r*sin(phi);


simplify(inv(E)*inv(J)*Df.')
```

ans =

$$\begin{pmatrix} \frac{\partial}{\partial r} f(r,\theta,\phi) \\ \frac{\frac{\partial}{\partial \theta} f(r,\theta,\phi)}{r \sin(\phi)} \\ \frac{\frac{\partial}{\partial \phi} f(r,\theta,\phi)}{r} \end{pmatrix}$$

```
%% calculation of the Laplacian
a=inv(J);
x_prime=[r, theta, phi];
Laplacian=0;
for i=1:3
    for j=1:3
        for k=1:3

            Laplacian=Laplacian+ a(i,j)*diff(a(i,k),x_prime(j))*Df(k)+a(i,j)*a(i,k)*diff(diff(f


        end
    end
end

simplify(Laplacian)
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ans(r, theta, phi) =

$$\frac{\sin(\phi)^2 \frac{\partial^2}{\partial \phi^2} f(r,\theta,\phi) + \frac{\sin(2\phi)\frac{\partial}{\partial \phi} f(r,\theta,\phi)}{2} + r^2 \sin(\phi)^2 \frac{\partial^2}{\partial r^2} f(r,\theta,\phi) + 2\, r \sin(\phi)^2 \frac{\partial}{\partial r} f(r,\theta,\phi) + \frac{\partial}{\partial}}{r^2 \sin(\phi)^2}$$