Transformed E&M I materials

Mathematical materials
(Griffiths Chapter 1)

TIMELINE

Prof A covers this in lectures 1-4.
Prof B. mixes with Chapter 2.
Transformed course covered in lectures 1-4, combined with Chapter 2.

TOPICS

- Div, grad, curl
- Line, surface, volume integrals
- Curvilinear coordinates
- Dirac delta function
- Vector fields (potentials)

LEARNING GOALS

Students should be able to:

1. Evaluate the integral from negative infinity to infinity of the delta function, \( \delta(x) \)
2. Evaluate the 3-dimensional divergence of \( 1/r^2 \) in the \( \hat{r} \) direction
   \[ 4\pi \delta^3(r) \]
3. Evaluate the integral of a function times the delta function
4. Be able to evaluate the integral of \( 1/(x-r)^{3/2} \) dx
5. Give a geometrical description of the divergence theorem, and fundamental theorem for curls.
6. Change a multidimensional integral in Cartesian coordinates to one in another coordinate system using the Jacobian.
CLASS ACTIVITIES

Visualization
Spherical coordinates
http://www.math.umn.edu/~nykamp/m2374/readings/sphcoord/

Visualization
Divergence and curl:
http://www.math.umn.edu/~nykamp/m2374/readings/divcurl/
http://www.math.umn.edu/~nykamp/m2374/readings/curlcomp/

Visualization
Several other math concepts
http://www.math.umn.edu/~nykamp/m2374/readings/

Group Activity
Vector in Curvilinear Coordinates
Oregon State University
Students working in small groups find the differential displacement vector in cylindrical and spherical coordinates.

Tutorial
Two dimensional charge distribution
Paul van Kampen – Dublin University (In Tutorials 1-8 p. 25)
Two dimensional charge distributions. Practice in integration in polar coordinates. Calculate net charge on a disk, the problem is broken into pieces (find dA, write dQ, write out the integral, evaluate), and then do it again in Cartesian.

Kinesthetic Activity
Pointing coordinate vectors
Oregon State University
ALso, kinesthetic activity: given an origin in the corner, and defining obvious x/y/z axes in the room, everyone close your eyes and POINT in the direction of yhat, then rhat, thetahat, pihat. (Discussion of which *should* be different from each other!)