Homework 1

Phys 411

August 29, 2018

Due: Friday, September 7

1. Carroll, 1.4
2. Carroll, 1.5
3. Carroll, 1.7
4. Carroll, 1.13
5. Consider the action of electromagnetism:

$$S[A_\mu] = \int d^4x \left[-\frac{1}{4} F_{\mu\nu} F^{\mu\nu} + A_\mu J^\mu \right] . \tag{1}$$

Take the functional derivative of the action with respect to the vector potential A_μ by explicit subtraction:

$$\frac{\delta S}{\delta A_\mu} = \lim_{\epsilon_\mu \to 0} \frac{S[A_\mu + \epsilon_\mu] - S[A_\mu]}{\epsilon_\mu} , \tag{2}$$

and show that Maxwell's equations follow from it. Recall that Maxwell's equations in covariant form are

$$\partial_\nu F^{\mu\nu} = J^\mu . \tag{3}$$

You'll need to perform some integrations by parts to get the result in this form.