University of Minnesota
School of Physics and Astronomy

2025 Fall Physics 8011
Quantum Field Theory I

Assignment Solution

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October 27, 2025

HW4 Due to November 4 11:59 PM

Question 1

Problem 14.1

Derive a generalization of Feynman's formula,

$$\frac{1}{A_1^{\alpha_1} A_2^{\alpha_2} \cdots A_n^{\alpha_n}} = \frac{\Gamma(\sum_i \alpha_i)}{\prod_i \Gamma(\alpha_i)} \frac{1}{(n-1)!} \int dF_n \frac{\prod_i x_i^{\alpha_i - 1}}{(\sum_i x_i A_i)^{\sum_i \alpha_i}}. \tag{1}$$

Hint: start with

$$\frac{\Gamma(\alpha)}{A^\alpha} = \int_0^\infty dt\, t^{\alpha-1} e^{-tA}, \tag{2}$$

which defines the gamma function. Put an index on A, α and t, and take the product. Then multiply on the right-hand side by

$$1 = \int_0^\infty \delta(s - \sum_i t_i). \tag{3}$$

Make the change of variables $t_i = s x_i$ and carry out the integral over s.

Answer

Question 2

Problem 14.2
Verify eq. (14.23).

Answer

Question 3

Problem 14.5
Compute the $O(\lambda)$ correction ot the propagator in φ^4 theory (see problem 9.2) in $d = 4 - \epsilon$ spacetime dimensions, and compute the $O(\lambda)$ terms in A and B.

Answer

Question 4

Problem 16.1
Compute the $O(\lambda^2)$ correction in $\mathbf{V}_4$ in φ^4 theory in $d = 4 - \epsilon$ spacetime dimensions. Take $\mathbf{V}_4 = \lambda$ when all four external momenta are on shell, and $s = 4m^2$. What is the $O(\lambda)$ contribution to C?

Answer