

Physics 658 - Course Outline

- 1 -

I) 1, 2, 3's of 3, 2, 1

A) Structure of gauge theory
Lie group G i.e. $SU(N)$, $SO(N)$, etc.

B) QCD - $SU(3)_c$

- 1) $SU(3)$ gauge invariance
- 2) Feynman Rules
- 3) Renormalization Group
 - a) β -function
 - b) Asymptotic Freedom

C) Electroweak - $SU(2)_w \times U(1)_l$

- 1) Chiral gauge theory
- 2) Symmetry breaking & Higgs model
- 3) Feynman Rules
- 4) Technical Fine Tuning & triviality of Higgs
- 5) Running of g_1 & g_2 (β 's)

D) Not-quite-Unification

E) Neutrino Masses

- 1) See-Saw Mechanism

II) Introduction to SUSY

A) SUSY Algebra

B) $N=1$ Superspace, Superfields & SUSY transformations

C) Invariant Actions

1) W-Z model

2) SUSY QED

3) Gauge Theories, $SU(N)$

D) SUSY Breaking

1) O'Raifeartaigh Model

2) Fayet-Iliopoulos Model

3) Explicit but soft breaking

III) MSSM

A) Action

B) $\tan\beta$ and Spectrum

C) Feynman Rules

D) Renormalization Group & Unification

E) No-Renormalization Theorem

IV) SUSYGUTS :

- A) SU(5) minimal GUT
- B) SO(10)
- C) Gravity corrections

V) Supergravity

VI) $N > 1$ SUSY.

Conventions: (Bjorken & Drell)

$$g^{\mu\nu} = (+, -, -, -)$$

$$\epsilon^{0123} = +1$$

$$\{\gamma^\mu, \gamma^\nu\} = 2g^{\mu\nu} \quad , \quad \text{etc.}$$