Syllabus for PHYSICS 474 (Spring 2018)
Introduction to Particle Physics

Instructor: Dr. Bhupal Dev (Email: bdev@wustl.edu; Phone: 55843; Office: Compton 373)

Assistant to Instructor (AI): Yiyang Zhang (yiyang.zhang@wustl.edu)

Lecture Hours: M-W-F 12.00-13.00, Crow 205.

Office Hours: Wednesdays 13.30-15.30 or by appointment.

Course Website: http://physics.wustl.edu/bdev/

Homework: Will be posted on the course website every Friday, and will be due on the following Friday at the beginning of class. *Late homeworks will not be accepted* (exceptions granted *only* by prior arrangement with the instructor).

Exams: Mid-term 3/5/18 12.00-13.00; Final 5/9/18 10.30-12.30.
Both will be in-class, closed-book exams. You may bring a single page of A4 size hand-written "equation sheet" (can use both sides) and a non-programmable calculator. *You must attend both exams to pass this course.*

Grading: 20% mid-term, 30% final, 47% homework, 3% class participation and online course evaluation.

Textbook: *Introduction to Elementary Particles* (2nd edition) by David Griffiths, Wiley-VCH (2010). For further reading (strongly recommended), see e.g.
1. *Quarks and Leptons* by Francis Halzen and Alan Martin, John Wiley (1984).
2. *The Standard Model in a Nutshell* by Dave Goldberg, Princeton University Press (2017).
There are excellent online (free) resources as well, e.g.
3. *Review of Particle Physics* by Particle Data Group, http://pdg.lbl.gov/
4. *The Particle Adventure*, http://www.particleadventure.org/

Course Outline: Introduction to the Standard Model of particle physics, including symmetries, conservation laws, Dirac equation, Feynman diagrams, quantum electrodynamics, parton model, quantum chromodynamics, weak interactions, electroweak gauge theory, spontaneous symmetry breaking, Higgs mechanism, neutrino oscillations, physics beyond the Standard Model.

W 1/17:	Basic Building Blocks of Nature, Elementary Particles and Forces
F 1/19:	Relativistic Kinematics, Particle Decays and Scatterings
M 1/22:	Symmetries, Groups and Conservation Laws, Noether's Theorem
W 1/24:	The $SU(2)$ Group, Isospin Symmetry
F 1/26:	The $SU(3)$ Group, Isospin and Strangeness, Flavor Symmetry
M 1/29:	Discrete Symmetries (C, P, T), CPT Theorem
W 1/31:	CP Violation, CKM Mixing
F 2/2:	Bound States: Quarkonium, Mesons and Baryons
M 2/5:	Fermi Golden Rule, Decay Width, Cross Section
W 2/7:	Feynman Diagrams and Rules
F 2/9:	Dirac Equation and its Solution, Antiparticles
M 2/12:	Bilinear Covariants, Clifford Algebra
W 2/14:	Dirac, Weyl and Majorana Fermions
F 2/16:	Quantum Electrodynamics
M 2/19:	Electron-Muon Scattering, Helicity Conservation
W 2/21:	Crossing Symmetry, Møller and Bhabha Scattering
F 2/23:	Polarization Vector, Compton Scattering
M 2/26:	Loop Corrections, Renormalization, Running Coupling Constant
W 2/28:	Electron-Proton Scattering: Elastic vs. Inelastic
F 3/2:	Parton Model, Bjorken Scaling
M 3/5:	**Mid-term Exam (12.00-13.00)**
W 3/7:	Quantum Chromodynamics
F 3/9:	Asymptotic Freedom
3/12 - 3/16:	SPRING BREAK

M 3/19:	Weak Interactions, Parity Violation and $V - A$ Theory
W 3/21:	Muon Decay
F 3/23:	Neutron Decay
M 3/26:	Pion and Kaon Decay
W 3/28:	Neutral Current Interactions
F 3/30:	Electroweak Unification
M 4/2:	Gauge Symmetries: Abelian and Non-Abelian
W 4/4:	Spontaneous Symmetry Breaking
F 4/6:	Higgs Mechanism
M 4/9:	The Standard Model Lagrangian
W 4/11:	Experimental Tests of the Standard Model
F 4/13:	Evidence for Beyond Standard Model Physics
M 4/16:	Neutrino Oscillations, PMNS Mixing Matrix
W 4/18:	Seesaw Mechanism, Leptogenesis
F 4/20:	Grand Unification: $SU(5)$ and $SO(10)$
M 4/23:	Supersymmetry
W 4/25:	Minimal Supersymmetric Standard Model
F 4/27:	Including Gravity: Towards a Theory of Everything
W 5/9:	**Final Exam (10.30-12.30)**