PHYS 6380 – Syllabus

Ryszard Stroynowski

Course Objective:

The course will cover a review of the current knowledge of elementary and fundamental particles and forces acting among them. In addition, it will cover particle acceleration and detection techniques and their applications to technologies used in every-day life. New important observations and discoveries in the field of particle physics, astronomy and cosmology related to physics of fundamental particles will be discussed.

SLOs:

1. Upon completion of this course the students will be able to analyze the production and decay chains of short-lived particles of matter, their quark content and the type and strength of forces governing basic interactions among the elementary components of matter.
2. Students will be able to evaluate rates of processes leading to particle-antiparticle transformations in the quark and neutrino sectors
3. Students will be able to synthesize the knowledge of particle interactions with matter to select suitable detection techniques for topics at the current frontier of research eg., neutrino oscillations, gravitational waves, etc.

There is no single textbook covering this material and the list of books referring to selected subjects is appended to this syllabus. In addition to the homework, the final grade will be based on the evaluation of a 30-45 minutes-long public oral presentation with power-point slides on one of the selected topics. The presentation should cover all elements of the course: explanation of the physical phenomena, observation and detection techniques, how the subject observations affect our understanding of the universe and the direction of future studies.

Grading

Homework 40%, Presentation – 40%, class and seminars participation – 20%
Presentation to be made in form of a one hour-long lecture to the class.

Homework will require application of relativistic kinematics, application of quantum numbers conservation laws and estimates of cross sections for production and decay processes. The graduate-level homework problems will require basic knowledge of quantum mechanics and relativity.

Each seminar subject will be complementary to the lectures.
Grading of seminar presentations will be done in collaboration with the audience.
Sample grading sheet:
Rate the following aspects in the range of 1 to 10 with 10 being best:

1) Review of the theoretical aspects of the subject. Comments on the current status of research in the field.
2) Organization and logic of the talk:
3) Transparencies: was the presentation clear? what was missing?
4) Questions: was the speaker able to answer questions?
   Add comments that will be helpful to the speaker: What element of this presentation would you like to see expanded further? What could be omitted?

Syllabus

Week 1	Introduction, discovery of atom's substructure, electron and neutron, elements of quantum mechanics and relativity
Week 2	Particles as waves - angular momentum and spin radioactivity, beta decays, muons and neutrinos
Week 3	Forces and interactions, cross sections, lifetimes
Week 4	Pions, kaons, resonances, particles ZOO
Week 5	Conservation laws and symmetries: P, C, CP**,** CPT
Week 6	Isospin, quark model, dynamic evidence for quarks
Week 7	Strong and weak interactions, Feynman diagrams
Week 8	Neutrinos, neutrino oscillations,
Week 9	Accelerators and colliders and their applications
Week 10	Detectors: trackers, fibers, calorimetry, Cerenkov, TOF, muons
Week 11	Electronics, Trigger, Monte Carlo, probability and statistics
Week 12	Cosmology: CMB, Dark matter, Energy, Gravitational Waves
Week 13	Students' seminars and discussions
Week 14	Students' seminars and discussions
Week 15	Big science projects: LHC, DUNE, CEPC, FCC, CMB4, LISA,..

Textbooks

Recommended (not required)	David Griffith, "*Introduction to Elementary Particles*"
	F. Halzen and A. Martin, "*Quarks and Leptons*"
Supplemental:	H.Kolanoski and N. Wermes, "*Particle detectors*"

Disability Accommodations: Students needing academic accommodations for a disability must first register with Disability Accommodations & Success Strategies (DASS). Students can call 214-768-1470 or visit http://www.smu.edu/Provost/ALEC/DASS to begin the process. Once registered, students should then schedule an appointment with the professor as early in the semester as possible, present a DASS Accommodation Letter, and make appropriate arrangements. Please note that accommodations are not retroactive and require advance notice to implement.

- **Religious Observance**: Religiously observant students wishing to be absent on

holidays that require missing class should notify their professors in writing at the beginning of the semester, and should discuss with them, in advance, acceptable ways of making up any work missed because of the absence. (See University Policy No. 1.9.)

- **Excused Absences for University Extracurricular Activities**: Students participating in an officially sanctioned, scheduled University extracurricular activity should be given the opportunity to make up class assignments or other graded assignments missed as a result of their participation. It is the responsibility of the student to make arrangements with the instructor prior to any missed scheduled examination or other missed assignment for making up the work. (University Undergraduate Catalogue). A student who is absent from class without valid reason for two consecutive weeks will be administratively dropped from the class by the instructor.

- **Health safety**

No masks will be required; students are welcome to wear masks if they choose. This masking policy is subject to change during the semester, and any changes will be posted clearly in Canvas announcements.

Masks are strongly recommended for all students but not required. This masking policy is subject to change during the semester, and any changes will be posted clearly in Canvas announcements.