SYLLABUS for ASTC25, Winter 2023.

Title: Astrophysics of Planetary Systems
Lecturer: Prof. Pawel Artymowicz
URL for *everything*: all course materials, assignments and prel. & results table is http://planets.utsc.utoronto.ca/~pawel/ASTC25
[Notice: Quercus does not have continuously updated information. We use it almost only for announcements and submission of assignments.]

Lectures (L): in AA205 on Thu 12-14
Tutorials (T): in AA205 on Thu 14-15
(Notice the order of lecture & tutorial on a given day is reversed w.r.t. original UTSC course calendar which says 12-13 tut, 13-15 lec); we start with lectures and finish with tutorial, it's more logical)

Assignments are due at 12:00 (beginning of lecture). Submit via Quercus.
Calendar of Lectures (L), Tutorials (T), Assignment due dates (A):

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12 Jan  L1+2   -- (no tutorial!)
19 Jan  L3+4    T1
26 Jan  L5+6    T2
 2 Feb  L7+8    T3   A1
 9 Feb  L9+10   T4
16 Feb  L11+12  T5   A2
23 Feb  --      --   reading week
 2 Mar  L13+14  T6   (midterm in class, almost 1hr, 14:05-15:00)
 9 Mar  L15+16  T7
16 Mar  L17-18  --   A3
23 Mar  L18-19  T8           [27 March=last drop date w/o penaly]
30 Mar  L20-21  T9   A4
 6 Apr  L22-24  T10

xx Apr  final exam:
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Syllabus is subject to some change, depending mostly on how fast we cover certain material, subjects will not change. Please download this syllabus weekly.
In parenthesis: chapt. of the Lissauer-dePater textbook to read ahead of the lecture.

1-2. Introduction and history
   * Organization of the course
   * The subject & key questions
   * History of the idea of many worlds
   * Newton &friends/enemies: Principia Mathem. Phil. Naturalis

3-4. Gravitational mechanics of planetary systems
   * Gravitational 2-body interaction
   * Kepler's laws with mathematical derivations
   * The 2-body problem and the elliptic motion: E, L, vs. a, e

5. Elements of celestial mechanics I
   * Tides in the solar system
   * Disruption of satellites: the Roche limit

6-7. Elements of celestial mechanics II
   * Precession of orbits and spin axes
   * Theory of perturbations vs. numerical computations
   * Restricted 3-body problem and the Hill problem

8. Orbits beyond the elliptic ones
   * Stability of motion
   * Lagrange points and in disk
   * Orbital resonances and chaos
   * The future of the solar system

9-10. Formation of disks and stars (ch. 15)
* Giant molecular clouds
* Jeans instability of protostellar cloud cores
* Opacity-limited fragmentation
* Simulations & the ubiquity of protostellar disks, brown dwarfs

11-12. Origins: Accretion disks (ch. 15)
* Analogue disks: AGN/quasar disks, and their accretion
* Accretion disk geometry
* Disks as evolving, shearing flows

13. Formation of planets: the main scenarios (ch. 15)
* Accumulation versus fragmentation: scenarios for the giants
* Gravitational stability of protoplanetary disks
* From dust to planetesimals

14. Formation of planets: standard scenario (ch. 15)
* From planetesimals to planetary cores: gravitational focusing
* Gravitational scattering of planetesimals into Oort cloud
* Isolation mass: a cause of giant impact epoch
* Late heavy bombardment
* Core-instability and gas accretion onto giant planets

15. Solar System: Minor bodies
* Clearing stage and Oort cloud formation
* Planetoids/dwarf planets: Eris and others
* Kuiper belt
    * Water in planetary systems
* Comets - icy dirtballs or dirty iceballs?
* Halley, Hyakutake, Hale-Bopp, Holmes2
* Where do Earth's oceans come from?
    * IDPs - Interplanetary Dust Particles
    * Asteroids, their belt & Kirkwood gaps
* Meteorites

16. Dust and planetesimals in extrasolar systems
* Interplanetary dust: Zodiacal light disk and Brownlee particles
* Vega-type systems, replenished dusty disks of planetary systems
* Beta Pictoris disk: evidence of planetesimals and planets

17. Planetary rings vs. extrasolar dust disks
* Saturn's rings
* Satellites launch waves at resonances, open gaps
* Rings as laboratory for disk-planet interaction
* Dust physics, processing, removal

18. Dust avalanches and irradiation instability in dusty disks
* Dust avalanches
* IRI. Role of optical thickness in instability
* Numerical simulations

19-20. Dynamics of protoplanets in disks: Migration
* Disk-planet interaction & diversity of exoplanets
* 3 different types of planet migration in disks
* Flow of gas around super-Earth
* Numerical simulations

21-23. Exoplanet discovery
* Methods: timing, radial vel., transits, microlensing, imaging
* Overview of results and examples of exoplanets
* Chemical correlations

24. Astrobiology and SETI
* Life on Earth: local or non-local origins?

* Life elswhere: Mars, Europa, moons of exoplanets?
* Habitable zones
* Drake's equation, SETI and the Fermi paradox
