PHYD26

Planetary Geophysics

Professor Julian Lowman
Offices: MP421 and EV344 (UTSC)
416-208-4880 (UTSC)
julian.lowman@utoronto.ca

COURSE DESCRIPTION:

This course introduces the physics governing some of the fundamental processes occurring in planets and moons as well as methods for inferring planetary structure. Specific topics will vary but will be related to:

- observations that reveal aspects of the evolution of terrestrial objects (e.g. planets, moons)

- planetary heat sources & thermal evolution (e.g. convection and its surface manifestations)

- effects of high temperature and pressure in planetary interiors (e.g., phase changes, stress-strain relationships)

- planetary structure and global shape (e.g. using gravity and rotation observations to infer composition properties)

- stress-strain in elastic media with application to utilizing observations of regional effects on topography (e.g., using lithospheric elasticity models)

Research articles and a focus on numerical modelling studies will be used to illustrate the course material.

Prerequisite:

Knowledge of PDE meaning and indice notation, vector calculus & Newtonian mechanics. No previous knowledge of Earth or planetary science required.

LECTURES:

Fridays at 11am in room MW160 and 1pm in room MW160 (one hour each). Tutorials or additional lectures will be held some weeks and will be at 2pm Fridays in MW160.

SCHEDULE

WEEK 1
Observations

WEEK 2
Internal Structure

WEEK 3
Convection Equations for Infinite Prandtl Number Flow

WEEK 4
Convection Equation Solutions

WEEK 5
Mantle Convection Studies

READING WEEK
Thanksgiving holiday week

WEEK 6
Mantle Convection Studies (continued)/ Parameterization

WEEK 7
Stress and strain

WEEK 8
The elastic lithosphere

WEEK 9
Geopotential

WEEK 10
Gravity/ The geoid

WEEK11
Mantle thermal structure/ phase changes

WEEK 12
Unfinished business

ASSESSMENT:

- A 3 hr final exam worth 60% of the final mark.

- Four problem sets. Each problem set will be worth 5% of the final mark.

- A literature report (7 page limit) on a subject to be agreed upon with the instructor. This could be something as simple as a review of three (or more)

papers on a common topic (e.g., analyses of elasticity of the Martian lithosphere). 10% of the final mark will come from this report.

- A twelve minute powerpoint presentation on the findings of the literature report followed by three minutes of questions (10%).

REFERENCES:

There is no required text for the course. Readings will be from the current literature and review articles. However, if you are interested in relevant texts, some are listed below.

Mantle Convection in the Earth and Planets (Schubert, Turcotte & Olson, 2001).

Geodynamics, 2nd or 3rd edition (Turcotte & Schubert, 2001).

Hydrodynamic and Hydromagnetic Stability (Chandrasekhar, 1961).

Physics of the Earth, 4th edition (Stacey and Davis, 2008)

Planetary Sciences (De Pater & Lissauer, 2001)

LECTURE NOTES:

In addition to the material delivered in class some material will be posted online.

OFFICE HOURS:

Please arrange appointments by e-mail.

Due dates will appear on the assignment handouts. Due to COVID protocols deadlines have some flexibility. However, it is strongly that recommended that all students do their best to adhere to the set deadlines. I cannot post solutions for the class until all assignments are received. Assignments should be handed in as hardcopies, in class, at 11 am. Electronic submissions are not permitted unless authorized in advance.