Physics and Astronomy
School of Physical and Chemical Sciences

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

General Course Information

ASTR112 – Astrophysics

0.125 EFTS 15 Points First Semester

Staff

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Course Description

ASTR112 Astrophysics is a 15-point course offered in the first half of the year and designed to give students a general introduction to modern astronomy emphasizing the important physics. The level of the lectures is essentially descriptive with some mathematics and involves discussion of the relevant principles of physics.

Goals of the Course

- Provide foundation knowledge of Astrophysics for students advancing in an astronomy or physics BSc or BSc(Hons) degree.
- Illustrate key concepts in physics using the medium of astronomy, where the Universe becomes our laboratory for studying physics at extreme scales.
- Give students experience of analysing and solving astrophysical problems, and in basic astrophysical data analysis.

Learning Outcomes

Students will:

- develop and be able to demonstrate basic scientific competency to solve appropriate problems in basic astrophysics.
- develop and be able to demonstrate basic astrophysics data analysis skills using software designed to simulate astronomical observations.
- develop and be able to demonstrate written communication skills.

Pre-requisites
A background in physics and mathematics to at least NCEA Level 2 is desirable. Most students will have taken these subjects at NCEA Level 3.

Lectures
The course comprises three lectures per week during the first semester (Terms 1 and 2). You should check your personal timetables at https://mytimetable.canterbury.ac.nz/aplus/apstudent for scheduling of lecture times/venues.

Summary of Course Content
ASTR112 is a cutting-edge introduction to modern astrophysics for those potentially interested in further study. We start by explaining how stars shine, and follow their evolution from birth to violent death. We explore strange new worlds around other stars and then move out into the cosmos, viewing our own Galaxy across the electromagnetic spectrum and revealing the evidence for Dark Matter and supermassive black holes. We then use our telescopes as time machines to look out and back in the Universe, studying other galaxy systems and the origin and fate of the Universe as a whole.

- ***Sun and Stars:*** *How can we study the stars? Characteristics of electromagnetic radiation and matter. The Sun and how it shines. Distance to stars. The Hertzsprung-Russell diagram; Internal stellar structure; Stellar Evolution: protostars to stellar death – white dwarfs, planetary nebulae, supernovae, neutron stars and black holes.*
- ***Planets and Exoplanets****: How do planets form, and how do we explain the origin of our own solar system? The diversity of planetary evolution, from rock and ice worlds to gas giants.*
- ***The Milky Way Galaxy:*** *How do we observe the Galaxy? The effects of cosmic dust and the nature of the interstellar medium. Star formation, spiral structure. Galactic rotation and evidence for Dark Matter. The centre of the Galaxy and supermassive black holes.*
- ***Galaxies and Cosmology:*** *Galaxies beyond the Milky Way; Hubble's law and the distance scale; What is the large-scale structure and fate of the Universe?*

Course Assessment
10% homework: 5 problem-solving homework assignments.
20% computer laboratories: 5 written reports on computer laboratories.
15% Mid-semester Test, 1 hour.
55% Final Examination, 3 hours.

Mid-term test
The test will cover material from the first part of the course (The Sun and Stars) and will comprise 15% of the final mark. The time and location should be confirmed on your timetable closer to the time of the test, but is generally in week 5-7 of the semester.

Computer Laboratories and Problem-Solving Skills Tutorials
As well as lectures, there will be a session that generally alternate between problem-solving skills tutorials and computer-based astronomy laboratory exercises.

In the first week, the session will run as an active tutorial where students can discuss course material with the teaching staff. Staff will go through and assist students in attempting astrophysical problems similar to those on the homework sheet and at the level that you will encounter in the test and exam. Homework will be on LEARN prior to the tutorial and can be attempted during the tutorial and tutors can be asked for help at this time. The homework will carry 10% of the total mark. The first homework will be formative – you should attempt it and check the model answers to see how well you did, but it will not be formally assessed.

The computer labs will run in the alternate weeks. They make use of computer software which simulates astronomical observing projects, and other web-based astronomy activities. You will have a one-hour session with teaching staff in the computer lab to start the assignment and to

make sure that you understand the aims and that you can use the software. You are then expected to complete the laboratory in your own time. It should take about 2-3 hours to complete the laboratory. You will have one week to complete and write up a formal report on the laboratory. There are five lab reports giving 20% of the final mark.

Tutorial/Computer Laboratory Timetable for 2023

Session	Date	Activity (Tutorial or Computer Lab)	Assessment due
Term 1			
Week 1	23/24 Feb	Tutorial 1 (Sun and Stars)	
2	2/3 Mar	Computer lab 1: Solar rotation	HW1 not assessed
3	9/10 Mar	Tutorial 2 (Sun and Stars)	Lab 1
4	16/17 Mar	Computer lab 2: Star clusters	HW 2
5	23/24 Mar	Tutorial 3 (Sun and Stars)	Lab 2
6	30/31Mar	Tutorial 4 (Planets and exoplanets)	HW 3
Term 2			
7	27/28 Apr	Computer lab 3: Planetary science	HW 4
8	4/5 May	Tutorial 5 (Galaxies and Cosmology)	Lab 3
9	11/12 May	Computer lab 4: Hubble's Law	HW 5
10	18/19 May	Tutorial 6 (Galaxies and Cosmology)	Lab 4
11	25/26 May	Computer lab 5: Large Scale Structure	HW 6
12	1/2 June	Tutorial 7 (Galaxies and Cosmology)	Lab 5

Recommended Textbooks

- Green and Jones: Introduction to the Sun and Stars (Cambridge University Press, 2015, 2nd edition).
- Jones and Lambourne: Introduction to Galaxies and Cosmology (Cambridge University Press, 2015, 2nd edition)

Numerous other astronomy texts suitable for supplementary reading are available in the Engineering and Physical Sciences Library.

General Physics and Astronomy Information

Please consult the document General Information for Physics and Astronomy Students on the Physics and Astronomy Web Page:
https://apps.canterbury.ac.nz/1/science/phys-chem/PHYS%20-%20Course%20Outlines/General.PDF

Marks and Grades

The following numbers should be considered as a guide to the expected grades under normal circumstances. The School reserves the right to adjust mark/grade conversions, if necessary.

Please note that for all invigilated assessments (tests and exams) worth 33% and above, failure to obtain a mark of at least 40% will result in a final grade no higher than an R at 100 and 200 level, and a C- at 300 level.

Grade:	**A+**	**A**	**A−**	**B+**	**B**	**B−**	**C+**	**C**	**C-**	**D**	**E**
Minimum mark %:	**90**	**85**	**80**	**75**	**70**	**65**	**60**	**55**	**50**	**40**	**0**