Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	2024-2025
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Leek Meng Lee
Course Author Email	mlleek@ntu.edu.sg
Course Title	Introductory Astrophysics
Course Code	PH2401
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	PH1104, PH1107
Co-requisites	
Pre-requisite to	PH3403
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

This is a first course in astrophysics. The objective of this course is to allow you to be aware of the characteristics of our universe. We begin from the neighbourhood of our solar system, to the stars in our Milky Way galaxy, to the large scale structures of our universe. You will also be shown the tools used for gathering astronomical data through observations. The highlight of this course is that you will see the applications of various topics in physics in explaining a wide range of astrophysical phenomena.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Recall the various methods of measuring distances in the universe and apply them.
ILO 2	Recall the physical principles behind the formation of spectral lines and apply them to obtain information about astronomical objects.
ILO 3	Recall the basic facts of our Sun and the other planets in the solar system.
ILO 4	Describe how planets outside our solar system are detected and the physical principles behind how their properties are determined.
ILO 5	Explain how the external radiation from stars fits with that of a black body.
ILO 6	Construct the Standard Model of Stellar interior that describes how heat is transported from the core to the exterior.
ILO 7	Compare the various nuclear reactions that take place in the core of stars.
ILO 8	Describe how stars will evolve after they used up their nuclear fuel in their cores.
ILO 9	Describe the origin and composition of the interstellar/intergalactic medium.
ILO 10	Recall and describe the classification and properties of various types of galaxies
ILO 11	Recall the mechanisms behind the formation of the largest structures of galaxies that make up the entire universe.
ILO 12	Deduce the equations that describe our universe under the assumption of homogeneity and isotropy and apply them.
ILO 13	Describe the early history of our universe during the era right after big bang.

Course Content

Astrometry
Photometry
Telescopes
Sun, Mercury, Venus, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto and other minor bodies
Exoplanets
Blackbody radiation
Hydrostatic equilibrium, convection and radiation
nuclear fusion
Hertzsprung-Russell diagram
White dwarf stars, neutron stars and black holes
Interstellar, intergalactic medium
Hubble classification of galaxies
Galactic walls, filaments and BAO bubbles
Friedmann equations and Big Bang theory
Cosmic Microwave Background Radiation
GUT era, inflation, baryongensis
Electroweak transition
Recombination and radiation-matter decoupling

Reading and References (if applicable)

a. Chaisson, Eric, Stephen McMillan, and Emily Rice. *Astronomy today 9th Edition*. Upper Saddle River, NJ:: Pearson/Prentice Hall, 2020, ISBN: 978-0136681069
b. Carroll, Bradley W., and Dale A. Ostlie. *An introduction to modern astrophysics*. Cambridge University Press, 2017, ISBN: 978-1108422161

NOTE: The above readings comprise the foundational readings for the course and more up-to-date relevant readings will be provided when they are available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Observational Astronomy 1, Astrometry, Photometry	1	References and lecture notes	In-person	
2	Observational Astronomy 2	2	References and lecture notes	In-person	
3	Solar Neighbourhood	3	References and lecture notes	In-person	
4	Exoplanets	4	References and lecture notes	In-person	
5	Stellar Physics: Exterior	5	References and lecture notes	In-person	
6	Stellar Physics: Interior	6	References and lecture notes	In-person	
7	Stellar Physics: Core	7	References and lecture notes	In-person	
8	Stellar Physics: Evolution	8	References and lecture notes	In-person	Midterm I
9	Interstellar. Intergalactic Medium	9	References and lecture notes	In-person	
10	Galaxies	10	References and lecture notes	In-person	
11	Large Scale Structures in the Universe	11	References and lecture notes	In-person	
12	Cosmology: Basics	12	References and lecture notes	In-person	
13	Cosmology: Thermal History of the Universe	13	References and lecture notes	In-person	Midterm II

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lectures	Warm-up questions will be raised first, followed by lectures that further explain the physics based on the questions. Then wrap-up questions will also be provided.
Tutorial	The student will review main concepts learned in lectures. This helps them to digest and understand better.
Homework	The homework comprises standard textbook practice questions that are covered during tutorial. These will encourage the students to reflect upon what they learnt and promote deeper understanding. They will also develop the student's competence and perseverance in solving physics problems.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Summative Assessment (EXAM): Final exam(This is a 2hr 30 min written paper assessing the student's understanding of the entire course.)	All	Not Applicable	40	Individual	Analytic	Relational
2	Continuous Assessment (CA): Test/Quiz(Midterm Test I is a 1hr 15min written paper to assess student's understanding of the first part of the course.)	1 to 7	Not Applicable	20	Individual	Analytic	Relational
3	Continuous Assessment (CA): Test/Quiz(Midterm T est II is a 1hr 15min written paper to assess the student's understanding of the second part of the course.)	8 to 12	Not Applicable	20	Individual	Analytic	Relational
4	Continuous Assessment (CA): Assignment(This component is made up of 5 homework sets where students will work on problems that enforce and enhance their understanding.)	All	Not Applicable	20	Individual	Analytic	Relational

Description of Assessment Components (if applicable)

Formative Feedback

Formative feedback is given through discussion within tutorial lessons, a discussion after the midterm, and an examiner’s report for the final exam.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Curiosity	Basic
Problem Solving	Basic
Sense Making	Basic

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned readings, activities, assignments, attend all classes punctually and complete all scheduled assignments by due dates. You are expected to take responsibility to follow up with assignments and course related announcements. You are expected to participate in all project critiques, class discussions and activities.

Policy (Absenteeism)

In-class activities make up a significant portion of your course grade. Absence from class without a valid reason will affect your participation grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for in-class activities.

Policy (Others, if applicable)

Diversity and inclusion policy

Integrating a diverse set of experiences is important for a more comprehensive understanding of science.

It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.

To help accomplish this:
- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.

As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.

All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.