UNSW
THE UNIVERSITY OF NEW SOUTH WALES

FACULTY OF SCIENCE

SCHOOL OF PHYSICS

PHYS3160/4103/4160/9683

ASTROPHYSICS—the stars

Session 2, 2010

Faculty of Science - Course Outline - 2010

1. Information about the Course NB: Some of this information is available on the UNSW Virtual Handbook[1]

Year of Delivery	2010 (note: the course is offered only in even years)
Course Code	PHYS3160 and PHYS4160
Course Name	Astrophysics—the stars
Academic Unit	School of Physics
Level of Course	3rd year undergraduate and Honours
Units of Credit	3UOC
Session(s) Offered	S2
Assumed Knowledge, Prerequisites or Co-requisites	The course assumes familiarity with first year physics; e.g. PHYS1002 or PHYS1221 or PHYS1231; and with first year mathematics; e.g. MATH1231 or MATH1241. Second year Quantum Mechanics, PHYS2040, is required. The second year astronomy course, PHYS2160 (covering Galaxies) is not a formal pre-requisite, however it would help to have taken this course.
Hours per Week	2 hours of lectures per week
Number of Weeks	12 weeks
Commencement Date	26 July 2010

Summary of Course Structure (for details see 'Course Schedule')

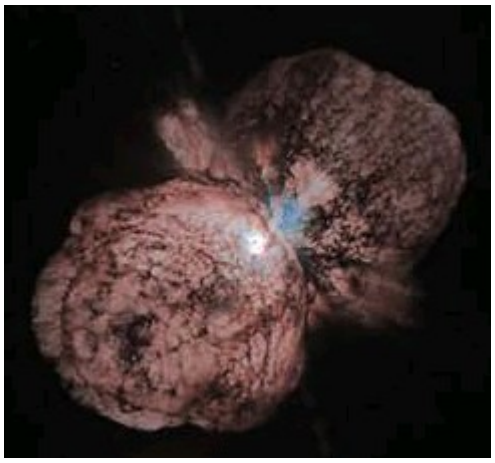
Component	HPW	Time	Day	Location
Lectures	*2*			
Lecture 1		*12am – 1 pm*	*Mon*	*OMB Room 151*
Lecture 2		*4pm – 5pm*	*Thu*	*OMB Room 151*
TOTAL	2			

2. Staff Involved in the Course

Staff	Role	Name	Contact Details	Consultation Times
Course Convenors		*Prof Michael Ashley* *Prof John Storey*	*Room 129, OMB* *Tel: 9385-5465* *m.ashley@unsw.edu.au* *Room 132, OMB,* *Tel: 9385-4578,* *j.storey@unsw.edu.au*	*Mondays 1-2*
Additional Teaching Staff	Lecturers & Facilitators	Dr Nick Tothill		
	Tutors & Demonstrators			
	Technical & Laboratory Staff			
	Other Support Staff			

[1] UNSW Virtual Handbook: http://www.handbook.unsw.edu.au/2006/index.html

3. Course Details

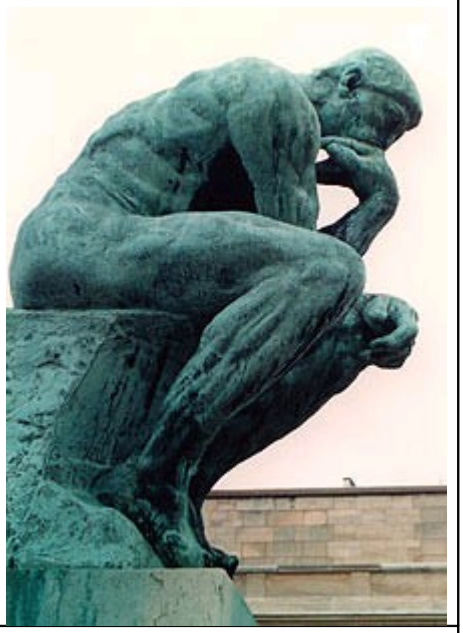
Course Description[2] (Handbook Entry)	Stellar radiation, spectra classification. Hertzsprung Russell diagrams, determination of stellar masses and radii. Equations of stellar structure, energy sources in stars, nuclear reaction cycles energy transport, equations of state, degeneracy, opacity. Properties of main sequence stars, stellar evolution, structure of red giants and white dwarfs. The solar atmosphere. 
Course Aims[3]	The stars form the basic building block of our Galaxy, and make up one of the fundamental scales on which structure is found in the Universe. This course provides an introduction to the physics of the stars. The aim is to give students an introduction to our state of knowledge about the stars, their physical parameters, how they function and how they evolve. The basic mathematical formalism governing the physics of the stars is presented, though the detailed solution of the equations is not attempted. The course aims to instruct students in four basic areas concerning the stars:  (a) The observational properties of stars – their masses, sizes, luminosities and distances, and how these properties are determined.

[2] UNSW Virtual Handbook: http://www.handbook.unsw.edu.au/2006/index.html

[3] Learning and Teaching Unit: http://www.ltu.unsw.edu.au

	(b) The equations of stellar structure – the fundamental equations that govern the behaviour of stars, including the approximations made to derive them and their range of validity. (c) The physics of stellar interiors – the nuclear reactions taking place in the cores of stars and the environment in which these can occur. (d) The evolution of stars – the life cycle of stars, from their formation in molecular clouds, their hydrogen-burning fusion stage on the main sequence, to their post main sequence evolution off the main sequence, once the core hydrogen fuel has been exhausted.
Student Learning Outcomes[4]	By the end of this course you will • have gained an understanding of the basic physical parameters of stars, • have learnt about the life cycle of stars, • know how to formulate the equations governing the structure of stars, and • have gained an appreciation of the physics that governs the energy production within stars.

Graduate Attributes Developed in this Course[5]

Science Graduate Attributes[5] (maybe replaced by UNSW, School or professional attributes)	**Select the level of FOCUS** *0 = NO FOCUS* *1 = MINIMAL* *2 = MINOR* *3 = MAJOR*	**Activities / Assessment**
Research, inquiry and analytical thinking abilities	3	Through lectures, assignments and examinations, the students will develop the analytical skills needed as a basis for research in astrophysics 
Capability and motivation for intellectual development	2	There is no specific activity for this attribute.

[4] Learning and Teaching Unit – Learning Outcomes: http://www.ltu.unsw.edu.au/ref4-2-1_outcomes.cfm

[5] Access the contextualised Science Graduate Attributes and your mapped courses: http://www.science.unsw.edu.au/guide/slatig/sciga.html (Mapped course will also be available at this site from March 2006)

Ethical, social and professional understanding	1	There is no specific activity for this attribute.
Communication	1	The course convenors encourage and expect the students to contribute questions during lectures.
Teamwork, collaborative and management skills	1	Students are encouraged to study in teams to solve problems and understand the material. Assignments must be original work, however. 
Information literacy	1	Information and literacy are common components of all courses in Physics.

Major Topics (Syllabus Outline)

Topic	**Textbook (Tayler: The stars, their structure and evolution) page reference**
Observational Properties of Stars	**Chapter 2**
Atmospheric windows	Kaufman & Freedman Ch 6.7
Black-body radiation	15-16
Luminosity and magnitude	12-14, 18
Colours	12
Surface temperature and colour indices	14
Spectral class	28-31
Masses	20-22
Radii	25-28
Mass-luminosity law	34
Hertzsprung-Russell diagram	32-34
Cluster diagrams	34-38
Luminosity class	Kitchin §3A.2, p112
Variable stars	41-43
Equations of Stellar Structure	**Chapter 3**
Hydrostatic equation	49-54
Mass equation	50-51
Physical state of stellar matter	55-56
Equation of state	58, 103
Gravitational potential energy	59
Virial theorem	54-55
Energy sources of stars	58-61
Energy balance equation	62
Energy transport	62-65
Radiation	62-65
Convection	64-79

	The Physics of Stellar Interiors	**Chapter 4**
	Nuclear energy release	80-82
	Hydrogen cycles	88-89
	Nuclear reaction rates	87-88
	Neutrino astronomy	90-91, 163-165
	Helium burning	94-95
	Degeneracy in stars	105
	Equation of state under degenerate conditions	105-108
	Sources of opacity	97-100
	Mean opacity	96
	Numerical values for opacity	101-102
	The Structure and Evolution of Stars	**Chapters 5, 6, 7, 8**
	Solution of structure equations	110-114
	General properties of homogeneous stars	121-125
	The main sequence	125-128
	The formation of stars	Kitchin §8A.1, p303-p308
	Pre-main sequence evolution	127-129
	Post-main sequence evolution	141-143
	The Giant stage	136-140
	Advanced evolutionary stages	188-205
	White dwarfs	208-213
	Neutron stars	214-217
Relationship to Other Courses within the Program	With PHYS2160, this course forms part of the undergraduate Astrophysics programme at UNSW.	

4. Rationale and Strategies Underpinning the Course

Teaching Strategies	Lectures will be used to introduce the various topics of the syllabus, and provide a foundation for further reading. Assignments give the student an opportunity to practice using their knowledge. The Louise Turtle Prize will be awarded to the top student taking the course as part of a Physics degree.

5. Course Schedule

Some of this information is available on the Virtual Handbook[6] and the UNSW Timetable[7].

Week	Lectures (day), Topics & Lecturers	Tutorials (day), Topics & Lecturers	Practical (day), Topics & Lecturers	Other	Assignment and Submission dates (see also 'Assessment Tasks & Feedback')
Week 2	mcba, atmospheric windows, blackbody radiation				
Week 3	Tothill, colours of stars, spectral types, observational properties				
Week 4	mcbal, hydrostatic equilibrium, virial theorem				
Week 5	Tothill, radiation, convection				
Week 6	mcba, nuclear energy release				
Week 7	mcba, nuclear reactions				
Week 8	jwvs, neutrino astronomy				
Week 9	jwvs, degeneracy in stars, opacity				
Week 10	jwvs, solution of equations of stellar structure				
Week 11	jwvs, the main sequence				
Week 12	jwvs, formation and evolution of stars				
Week 13	jwvs, the final stars of stellar evolution, black holes				

[6] UNSW Virtual Handbook: http://www.handbook.unsw.edu.au/2006/index.html

[7] UNSW Timetable: http://www.timetable.unsw.edu.au/

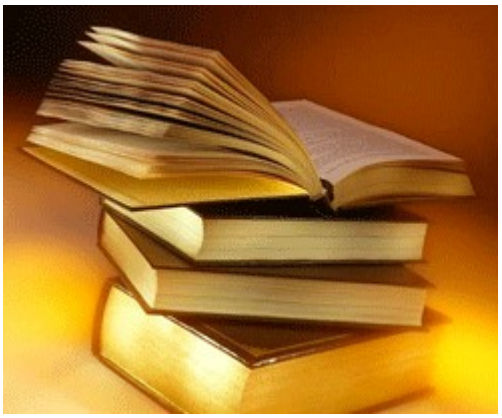
6.1 Assessment Tasks and Feedback—PHYS 3160

Task	Knowledge & abilities assessed	Assessment Criteria	% of total mark	Date of		Feedback		
				Release	Submission	WHO	WHEN	HOW
Mid-session test	The syllabus up to the week before the test	The degree to which the answers are correct.	20		2 Sep @ 4pm	mcba	within ~10 days of the test	marks
Two hour written examination	The syllabus	The degree to which the answers are correct.	60	TBA	TBA	UNSW	through formal UNSW procedures	marks
Two assignments	mcba's half of the course, and jwvs's half	The correctness and quality of the work done.	20	TBA	TBA	mcba and jwvs	within ~10 days of the due date	marks

6.2 Assessment Tasks and Feedback—PHYS 4103/4160/9683

Task	Knowledge & abilities assessed	Assessment Criteria	% of total mark	Date of		Feedback		
				Release	Submission	WHO	WHEN	HOW
Three hour written examination	The syllabus	The degree to which the answers are correct.	70	TBA	TBA	UNSW	through formal UNSW procedures	marks
One assignment	The second half of the course	The correctness and quality of the work done.	30	TBA	TBA	jwvs	within ~10 days of the due date	marks

7. Additional Resources and Support

Text Books	R.J. Tayler, "The Stars: their structure and evolution", Cambridge University Press (1994), Library Call Number P523.8/19. Available in the UNSW Bookshop.
Course Manual	Outline lecture notes will be provided.
Required Readings	None.
Additional Readings	***Additional Text Books:*** • A.C. Phillips, "The Physics of Stars", John Wiley & Sons. • R. Bowers and T. Deeming, "Astrophysics I: Stars". Note: "Astrophysics II: The Interstellar Medium", is the second half of this two-volume set and is a useful text book for the Honours year Astrophysics course. • C.R. Kitchin, "Stars, Nebulae and the Interstellar Medium". • M. Swarzschild, "Structure and Evolution of the Stars". • D. Menzel, P.L. Bhatnagar and H.K. Sen "Stellar Interiors". • C.W. Allen, "Astrophysical Quantities". • Danby, Kouzes and Whitney, "Astrophysics Simulations", Wiley. • M. Zeilik & S. Gregory, "Introductory Astronomy & Astrophysics", Chapters 8-17 (Saunders).  ***Introductory Texts*** The following are all good introductory texts on astronomy, with excellent pictures, but the material is covered at a lower level than this course: • W. Kaufmann, R. Freedman, Universe, Chapters 18-22 (Freeman) • M. Zeilik, The Evolving Universe, Chapters 13-17 (Wiley) • M. Seeds, Foundations of Astronomy, Chapters 7-14 (Wadsworth) • Fraknoi, D. Morrison & S. Wolff, Voyages through the Universe, Chapter 15-22 (Saunders) ***Maple Resources:*** • Primer for using Maple

	• Introduction to Maple, thanks to University of Durham. • School of Mathematics Guide to Maple.
Recommended Internet Sites	Google™ Australia
Societies	
Computer Laboratories or Study Spaces	

8. Required Equipment, Training and Enabling Skills

Equipment Required	 None.
Enabling Skills Training Required to Complete this Course	None.

9. Course Evaluation and Development

Student feedback is gathered periodically by various means. Such feedback is considered carefully with a view to acting on it constructively wherever possible. This course outline conveys how feedback has helped to shape and develop this course.

Mechanisms of Review	Last Review Date	Comments or Changes Resulting from Reviews
Course Review for 12 week session	01/07/08	The course material was revised to align with the 12 week session. Online notes rewritten by Storey for the 2nd half of the course.
Major Course Review	July 2006	The course material was re-written in 2006 by Ashley and Webb.
CATEI[8]		Periodically we will gather student evaluative feedback on the course, using among other means, UNSW's Course and Teaching Evaluation and Improvement (CATEI) Process. Student feedback is taken seriously, and continual improvements are made to the course based in part on such feedback.
Other		

[8] Science CATEI procedure: http://www.science.unsw.edu.au/guide/slatig/catei.html

Administration Matters

Information about each of the following matters is best presented in a generic School handout or webpage. Reference should be made in every course handout to where the information can be found, and the importance of being familiar with the information.

<table>
<tr><td>Expectations of Students</td><td colspan="3">80% attendance at lectures.</td></tr>
<tr><td>Assignment Submissions</td><td colspan="3">Hand assignments to the lecturers by the deadline.</td></tr>
<tr><td>Occupational Health and Safety[9]</td><td colspan="3">Information on relevant Occupational Health and Safety policies and expectations for UNSW is at: www.riskman.unsw.edu.au/ohs/ohs.shtml</td></tr>
<tr><td>Assessment Procedures</td><td colspan="3">You should follow the procedure prescribed in the University's 'Rules and Procedures' that can be found in the University Calendar. Point out in your letter that part of the assessment has been affected, and give the reasons (with any documentation) for your absence. The Registrar will inform both you and the School of Physics whether the absence is approved or not, and we shall adjust the assessment accordingly.</td></tr>
<tr><td>Equity and Diversity</td><td colspan="3">Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course Convenor prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the Equity and Diversity Unit (9385 4734 or www.equity.unsw.edu.au/disabil.html).

Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made. Information on designing courses and course outlines that take into account the needs of students with disabilities can be found at: www.secretariat.unsw.edu.au/acboardcom/minutes/coe/disabilityguidelines.pdf</td></tr>
<tr><td rowspan="2">Grievance Policy[10]</td><td>School Contact</td><td>Faculty Contact</td><td>University Contact</td></tr>
<tr><td>Sue Hagon
Physics Friend
s.hagon@unsw.edu.au
Tel: 9385-6293

or

A/Prof Gary Morriss
Undergraduate Director</td><td>A/Prof. Julian Cox
Associate Dean (Education)
julian.cox@unsw.edu.au
Tel: 9385 6063</td><td>Graduate Research School
Tel: 9385 2969

Compass University Counselling Services Tel: 9385 5418</td></tr>
</table>

[9] UNSW Occupational Health and Safety: www.riskman.unsw.edu.au/ohs/ohs.shtml

[10] UNSW Grievance Policy: http://www.infonet.unsw.edu.au/poldoc/student_grievance_resolution.pdf

10. UNSW Academic Honesty and Plagiarism

Image credit: http://www.flickr.com/photos/28153108@N02/3521681167/

What is Plagiarism?

Plagiarism is the presentation of the thoughts or work of another as one's own.
*Examples include:

- direct duplication of the thoughts or work of another, including by copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;
- paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;
- piecing together sections of the work of others into a new whole;
- presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and
- claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†

For the purposes of this policy, submitting an assessment item that has already been submitted for academic credit elsewhere may be considered plagiarism.

Knowingly permitting your work to be copied by another student may also be considered to be plagiarism.

Note that an assessment item produced in oral, not written, form, or involving live presentation, may similarly contain plagiarised material.

The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does *not* amount to plagiarism.

The Learning Centre website is main repository for resources for staff and students on plagiarism and academic honesty. These resources can be located via:

www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- correct referencing practices;
- paraphrasing, summarising, essay writing, and time management;
- appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts.

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle
† Adapted with kind permission from the University of Melbourne.