DYNAMICS, CHAOS AND SPECIAL RELATIVITY.

PHYS2100

Lecturers

Professor M.D. Gould
Dr M Drinkwater
Dr.J. Ross

Dynamics, Chaos and Special Relativity
PHYS2100
2004

Units **#2**
Class contact hours **4C (34L, 18T)**
Other formal details **2nd Semester**

Pre: (PHYS1001) + (PHYS1002) + (MATH1052)
Inc: PH244 or 255 or MA255

Purpose of the Course

An introduction to Lagrangian and Hamiltonian mechanics including an elementary treatment of chaos in non-linear dynamical systems. Calculus of variations, constraints, generalised coordinates, geometrical methods. An introduction to Special Relativity including relativistic particle mechanics.

This course is intended to introduce Physics students to the idea of chaos in non linear dynamical systems through the particular example of a driven nonlinear pendulum. The student is made aware that such system are generic, that is, the norm not the exception. This is the first time Physics students see the possibility that a dynamical system can be at once deterministic and unpredictable. The course also introduces relativistic particle mechanics and elementary space-time physics.

Staff

Professor M.D. Gould
Rm 360 Priestley Building (#670
mdg@maths.uq.edu.au
Office Hours: Tuesday2-3pm, Thursday1-2pm

Dr. M Drinkwater (Course coordinator)
Rm 225 Physics Annexe Building (#6)
mjd@physics.uq.edu.au
Office Hours: Tuesday 3-5pm

Dr. J Ross
Rm 226 Physics Annexe Building (#6)
ross@physics.uq.edu.au
Office Hours: Mon 8-12, Tue 10-12, Wed 10-12

Online Information.

Both the course profile and course material can be found by going to the Physics home page (www.physics.uq.edu.au), selecting Teaching, then selecting either Course Profiles or Course Web Sites.

Assumed background

It is assumed that all students taking this course have done the main first year physics courses (PHYS1001) and (PHYS1002) and (MATH1051 +MATH1052)

Course goals

On completing this course students will:

- Be able to solve elementary mechanical problems using the Lagrangian and Hamiltonian formalism.
- Solve basic problems in the calculus of variations.
- Know the difference between a linear and nonlinear oscillator and be able to find the nonlinear frequency and draw the phase-space portrait.
- Understand what is meant by "chaotic dynamics" in terms of sensitive dependence on initial conditions,
- Understand how chaos arises in non linear Hamiltonian systems, and be able to determine which initial conditions lead to chaos, for driven systems with one degree of freedom.
- Understand the principles of special relativity and be able to solve simple relativistic mechanical problems.

Graduate Attributes:

The following graduate attributes will be developed in the course –

- In-Depth Knowledge in the Field of Study
- Effective Communication
- Independence and Creativity
- Critical Judgement
- Ethical and Social Understanding

The development of graduate attributes through course content, learning modes and assessment is outlined in the following tables.

For more information on the University policy on development of graduate attributes in courses,

PHYS2100 Graduate Attributes developed and how achieved

Learning experience	In-Depth Knowledge of the Field of Study	Effective Communication	Independence and Creativity	Critical Judgement	Ethical And Social Understanding
Lectures	subject matter covered	listening, note-taking, questioning, accessing web information		identification of essential physics of situation and synthesise links between pieces of information	a knowledge and respect of the scientific method
Tutorials	understanding and synthesising links between pieces of information	comprehending, effective interaction, conveying ideas in written, spoken and symbolic forms	Identifying problems and producing own solutions		Ethical standards in collaborations
Independent study	use of texts and other resource material, problem solving		working independently		

PHYS2100 Graduate Attributes assessed

Assessment task	In-Depth Knowledge of the Field of Study	Effective Communication	Independence and Creativity	Critical Judgement	Ethical And Social Understanding
Solutions to tutorial problems	encompassing competency in mathematical and analytical skills	writing, understanding of questions, drawing diagrams	ability to understand principles and develop own coherent solution	critical evaluation of solutions presented	applications of ethical standards in qualitative and quantitative solutions
Assignments	Ability to connect all aspects of theoretical knowledge to a range of topics	Ability to link and express theoretical knowledge in a cohesive and logical manner.			applications of ethical standards in using reference material
End of semester exam	in depth understanding and application of standard techniques, conceptualising physical situations, numerical problem-solving	writing, drawing diagrams, comprehending written questions	supervised independent work, free response, adaptation to unfamiliar problems	identification & analysis of problem	

Teaching and learning methods

3 lectures (approximately) per week (Monday 12.00 Rm 7-302 and Wednesday 2-4, Rm 7-302).
1 tutorial (approximately) per week (Wednesday 9.00, Rm 7-302)
You are strongly advised to attend all lectures and tutorials. In tutorials students are expected to work on tutorial problems provided.

Help outside class times: Your tutors are students, and they are not paid to provide help outside tutorial times, If you cannot get sufficient help during tutorials, try to see the lecturer during Consultation Hours(see above). It may be sometimes necessary to make an appointment.
Please don't try to ask mathematical questions by email.

Assessment program

The course is assessed in one mid-semester quiz, one 2 hour examination at the centrally timetabled end of semester examination and hand-in assignments. The relative contributions are:

- mid-semester quiz: 20%
- assignments: 20%
- final examination: 60%

The assignments will be set from weekly problem sheets, which will be handed out in lectures. You will be told the questions to be handed in for each assignment the week before the assignment is due. Make sure you put your name on top of each assignment.

Examination. The final examination at the end of the semester will consist of questions of the general type set for assignments or given on problem sheets, but will not necessarily be ones you have seen during the semester

Calculators. No calculators will be allowed in the final examination. They will not be needed.

Assessment criteria.

Assessment will be criterion based, and not norm based, as required by University policy.
The students understanding of the course will be shown by their being able to:

- Define, explain and interrelate the key concepts involved in the course.
- Recognise the regime of applicability of the theory presented.
- Use the basic theory to describe quantitatively the behaviour of important physical systems treated in the course.
- Apply the theory to new physical problems and obtain correct analytical and numerical results in the appropriate units of measurement.
- Utilise the appropriate mathematical and other techniques to derive relationships for physical quantities

This understanding will be assessed by requiring the student to:

- Complete written assignments.
- Attend written examinations and tests.

which in total will range over the topics, key concepts and class of problems covered in the course as set out in the Course Profile (unless notified to the contrary by the Course Coordinator(s)). The assessment program will not necessarily address every topic covered in the syllabus

Criteria for the award of grades

To earn a Grade of 7, a student must demonstrate an excellent understanding of the course material, and be highly proficient in applying appropriate techniques to accurately solve both theoretical and practical problems.

To earn a Grade of 6, a student must demonstrate a comprehensive understanding of the course material, and be proficient in applying techniques to solve both theoretical and practical problems. This may be exemplified by the ability to solve non-routine problems and apply ideas to novel situations.

To earn a Grade of 5, a student must demonstrate good understanding of the course material and adequate ability to apply techniques to solve problems, using and applying fundamental concepts and skills of the course.

To earn a Grade of 4, a student must satisfy the basic learning requirements for the course, such as understanding of the fundamental concepts and performance of basic skills. The student must demonstrate knowledge of techniques used to solve problems.

To earn a Grade of 3, a student must demonstrate some understanding of the basic concepts and knowledge of techniques used to solve problems. The student falls short of satisfying all requirements for a Pass but may be close to satisfactory overall, or have compensating strengths in some aspects of the course.

To earn a Grade of 2, a student, although failing to satisfy basic requirements of the course, must demonstrate some knowledge of the basic concepts and limited knowledge of techniques used to solve problems.

A student will earn a Grade of 1 if he/she shows a very poor knowledge of the basic concepts in the course material. This includes attempts at answering questions that demonstrate very limited understanding of the key concepts.

Assessment and grading

- Each assessment item will be given the weighting for the determination of the final grade as set out in the Course Profile.
- Assessment will be in terms of the extent to which the student has achieved the goals of the course. The grade awarded, which will be in the range 1 to 7, will reflect this achievement.
- Assessment will be based on the judgement of the assessors as to how well the particular item being assessed demonstrates the students level of understanding.
- Unless specified to the contrary, assessment will be carried out by the Course Coordinator(s) and other Teaching Staff assigned by the Head of Department.

Assessment policies

- As previously mentioned calculators will not be required in the final examination.
- Penalties for non-conformity with Assessment Program, such as late submission of work, non attendance at tests or examinations, plagiarism, illness and so on, will be in conformity with general University Policies dealing with these matters. Such policies are outlined in the Assessment rules, set out in the University of Queensland Calendar.

Plagiarism

The University expects and encourages you to act with integrity, ethically and with mutual respect for fellow members of the University community. A breach of the appropriate standard of conduct or of University rules may constitute misconduct and will be dealt with according to University procedures. See Undergraduate Handbook; Student services and Information Section. Also URL http://www.admin.uq.edu.au/HAI/hai-home.html

Collaboration on assignments is allowed, even encouraged, but you must write out your own solutions in your own way. Identical assignment solutions may share the marks. If you submit work that is not your own, no marks may be awarded.

Special examinations

If a student is unable to sit a scheduled examination for medical or other adverse reasons, she/he can and should apply for a special examination. Applications made on medical grounds should be accompanied by a medical certificate; those on other grounds must be supported by a personal declaration stating the facts on which the application relies; other corroborative evidence may also be accepted.

Applications for special examinations for central exams must be made to the Director of Studies in the Faculty. Applications for special examinations in departmental exams must be made to the course coordinator.

More information on the University's assessment policy may be found http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=30&s3=5

EPSA Faculty policy on the award of special and supplementary exams may be found at http://www.epsa.uq.edu.au/index.html?id=7674&pid7564

Feedback on assessment

You may request feedback on assessment in this course progressively throughout the semester from the course coordinator. Feedback on assessment may include discussion, written comments on work, lists of common mistakes and the like.

Students may peruse examinations scripts and obtain feedback on performance in a final examination provided that the request is made within six months of the release of final course results. After a period of six months following the release of results, examination scripts may be destroyed.

Information on the University's policy on access to feedback on assessment may be found at http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=30&s3=5

EPSA Faculty policy on feedback and re-marking may be found at http://www.epsa.uq.edu.au/index.html?id=7674&pid7564

Recommended texts and references

There is no prescribed text for this course. However the following books will assist understanding the core elements of this course;

- *Mechanics,* W. Chester
- *Introduction to Theoretical Mechanics,* Robert A. Becker,
- *Classical Mechanics*, Herbert Goldstein.

Library contact:

The liaison librarian for Earth Sciences/Maths/Physics is located in the Physical Sciences and Engineering Library in the Hawken Building and may be consulted for assistance in the course:

Physics: Leith Woodall
Email: l.woodall@library.uq.edu.au
Extension: 52367

Student with disabilities

Any student with a disability who may require alternative academic arrangements in any course offered by this department is encouraged to seek advice at the commencement of the semester from a Disability Adviser at the Student Support Services.

Assistance for Students:

Students with English language difficulties should contact the course coordinator or tutors for the course.

Students with English language difficulties who require development of their English skills should contact the Institute for Continuing and TESOL Education on extension 56565.

The Learning Assistance Unit located in the Relaxation Block in Student Support Services. You may consult learning advisers in the unit to provide assistance with study skills, writing assignments and the like. Individual sessions are available. Student Support Services also offers workshops to assist students. For more information, phone 51704 or on the web http://www.sss.uq.edu.au/.

Student Liaison Officer:

The School of Physical Sciences has a Student Liaison Officer as an independent source of advice to assist students with resolving academic difficulties.

The Student Liaison officer during semester 2 2004 will be Dr Peter Adams Rm 547 Priestly Building (email pa@maths.uq.edu.au)

Syllabus

- Dynamics of a single particle
- Calculus of variations
- Lagrange's and Hamilton's equations
- Poisson brackets
- Relativity Principle, Michelson-Morley experiment
- Special Relativity, Cartesian Tensors (four-vectors)
- The Lorentz Transformation, Relativistic Particle Dynamics.

Timetable for the Semester

PHYS2100	**Sem 2 2004**	**49 contact hours**	
Dynamics & Lagrangian Mechanics	M.D. Gould	42%.	21h
Hamiltonian Mechanics & Chaos	M Drinkwater	33%	16h
Special Relativity	J.E. Ross	25%...	12h

Day	Monday	Wednesday	Wednesday			
time	12	9	2-4			
room	7-302	7-302	7-302			
Date	26	28	28	July	4 hours	M.D.Gould
	2	4	4	August	14 hours	"
	9	**	**	"		"
	16	18	18	"		"
	23	25	25	"		"
	30	1	1	September	15 hours	MG,MG,JR
	6	8	**8** quiz	"		JR,JR,MG
	13	15	15	"		JR
	20	22	22	"		JR
	--	--	--	AVCC break		--
	4	6	6	October	16 hours	MD
	11	13	13	"		MD
	18	20	20	"		MD
	25	27	27	"		MD

** = EKKA holiday MD = M. Drinkwater JR = J. Ross

Mid-semester quiz: 2pm Wednesday September 8.