Slide 1

DISTANCE/ONLINE LEARNING IN PHYSICS AT DEAKIN UNIVERSITY AUSTRALIA

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DISTANCE EDUCATION IN STEM

Considerable interest exists across the world.

- University of Florida
- North Carolina State University
- SUNY system
- University of North Dakota
- Georgia Tech
- Stanford University
- Sloan Foundation and Consortium

- Satellite campus?
- Fully on-line?
- Asynchronous or synchronous?
- Hybrid?

"Engineering Education Anywhere, Anytime" (Sloan Consortium, 2005)

Slide 3

DISTANCE EDUCATION IN STEM

- John Henessey, president, Stanford University
  - –The large lecture theatre filled with students is no longer an effective way to teach engineers.
  - –The cost of education has risen much faster than the cost of everything else.
  - –New models of education are needed.

Slide 4

AUSTRALIA

- Large, dry continent .
- Isolated in the south Pacific.
- ~24 million people.
- 7 cities.
- Very isolated communities.
- Shortage of engineers.
- Distance-education is well established.

Slide 5

AUSTRALIAN DISTANCE-ED CENTRES

- Central Queensland University
- University of Southern Queensland
- Charles Sturt University
- Deakin University
- Monash University Gippsland
- University of Adelaide, Flinders University and the University of South Australia
- University of New England
- Curtin, Murdoch, and Edith Cowan Universities.

Slide 6

DEAKIN UNIVERSITY

- 4 campuses in Victoria.
  - Melbourne
  - 2 Geelong
  - Warrnambool
- 51,000 students
- 30% off-campus (distance/on-line)
- Off-campus students scattered around Victoria, Australia and overseas.

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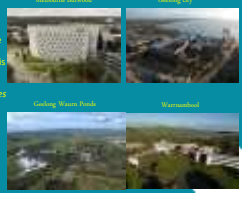
DEAKIN UNIVERSITY

- 8th largest university in Australia.
- One of 8 distance-education centers established by the Australian Government in the late 1980's.
- Off-campus ("cloud campus" is the fastest growing cohort of students.
- Ranked #45 in the world *Times Higher Education* Top 100 universities under 50 years old.
- Ranked #324 in the world *QS World University Rankings*



Slide 8

SCHOOL OF ENGINEERING

- Founded in 1991 at Geelong Waurn Ponds campus.
- Four undergraduate majors:
  - Civil
  - Mechanical
  - Mechatronics
  - Electrical and electronics.
- Deakin University offers an accredited Bachelor of Engineering course in both on-campus mode and off-campus mode (hybrid model of DEOnline ed.)
- Accredited by the Institution of Engineers Australia.
- Member Washington Accord.
- About 28% of enrolments are off-campus, both in Australia and overseas.
- Off-campus students study from home or workplace.
- Delivering classes to off-campus students has been a significant challenge over the years.

Slide 9

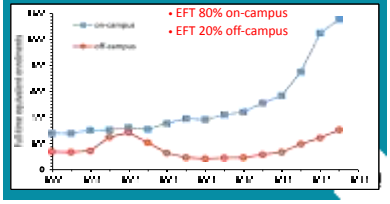
STUDENT AND FACULTY PROFILE

- Currently ~940 effective full-time undergraduate students, 2000 total enrolments.
- 18-20 years old, fresh from high school, mainly on-campus.
- Mature-age in trades and technical professions, mainly off-campus.
- Overseas, both on-campus and off-campus.
- 45 academic teaching staff.

Slide 10

SCHOOL OF ENGINEERING ENROLMENTS

- EFT 80% on-campus
- EFT 20% off-campus



Slide 11

WHERE ARE OUR STUDENTS?

Home location of off-campus cohort 2015

We also have overseas off-campus students in:

- New Zealand
- China
- Malaysia
- USA
- Europe
- India
- Singapore

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SOME OF THE MORE ISOLATED OFF-CAMPUS STUDENTS HAVE BEEN FROM

- Whyalla South Australia
- Karratha, Western Australia
- Darwin, Northern Territory
- Mt Isa Queensland
- Lake Cargelligo New South Wales
- Broken Hill New South Wales
- Elcho Island, East Arnhem, Northern Territory
- A gold mine somewhere in Indonesia,
- At sea on a ship.

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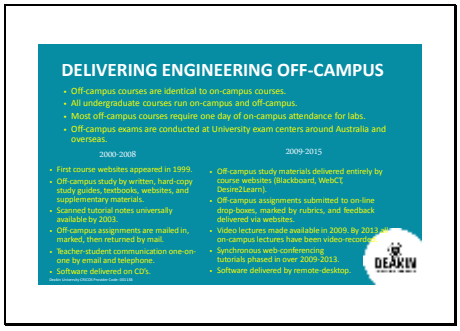

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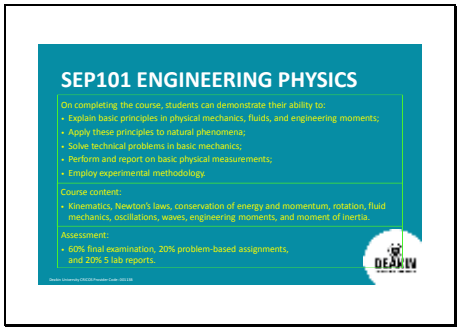

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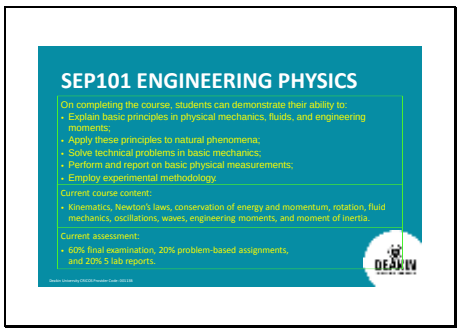

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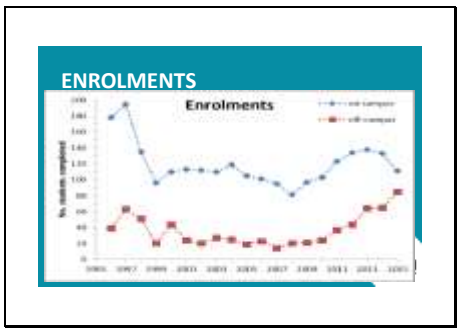

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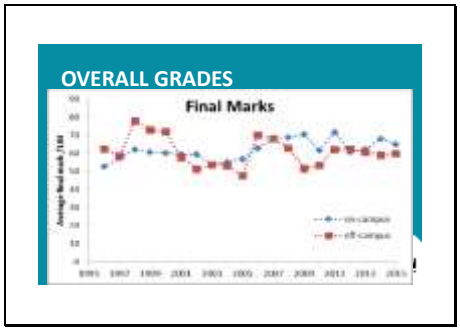

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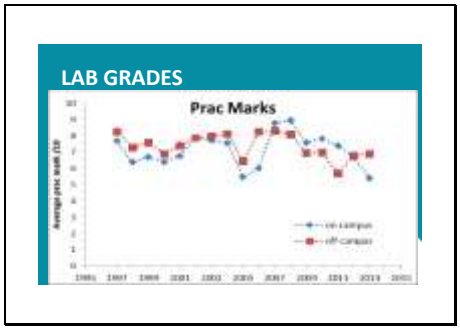

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LMS BECOMES THE COURSE SCAFFOLD

- The learning management system (D2L) forms the structure of the course.
- The content is presented as an on-line study guide. Topics presented week-by-week.
- Class announcements are posted on the home page.
- All teaching materials are posted to the course web-site.
- Assignments can be submitted and marked on-line via drop-box folders and online rubrics.
- Multi-choice quizzes supplement assessment.
- Students communicate with each other via the discussion boards.
- Links to outside resources are put in the weekly course outline.

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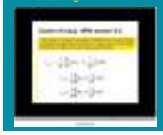
ON-LINE RECORDED LECTURES

- All on-campus lectures automatically recorded and made available in multiple formats, downloads, and streaming.



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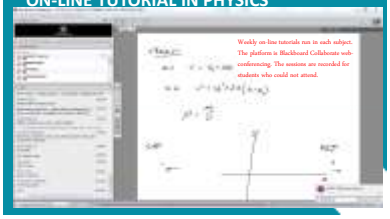
ON-LINE TUTORIAL IN PHYSICS



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PRACTICALS AND LAB CLASSES

- The biggest challenge in teaching engineering by distance.
- Deakin has tried a number of solutions:

1. Weekend lab classes
2. video-recorded experiments
3. computer simulations
4. lab kits and associated at-home experiments
5. remote-controlled lab experiments
6. at-home design projects
7. web broadcasting of lab classes
8. an intensive residential school.

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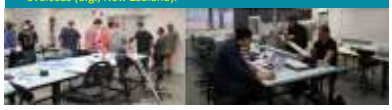
WEEKEND LAB CLASSES

- The most common means of delivering practical work to distance students.
- It works well for students from Geelong and Melbourne.
- It is hard for country and interstate students.
- It is impossible for students posted overseas (e.g., New Zealand).



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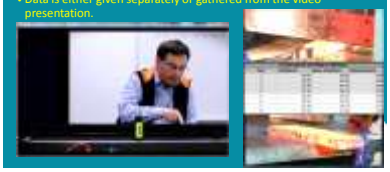
VIDEO-RECORDED EXPERIMENTS

- An experiment is video-recorded and released to the students.
- Data is either given separately or gathered from the video presentation.



Slide 25

COMPUTER SIMULATIONS

- Computer simulations give the student some practical experience.
- It is limited because it is not "hands on".

Slide 26

LAB KITS AND AT-HOME EXPERIMENTS

- Very successful in electronics and mechatronics at first and second year.
- Limited to available components but getting better.

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The Experiments

Exercise	Activity
A1	Introduction to the breadboard and the transistor
A2	Basics of logic gates
A3	Universality of NAND and NOR gates
A4	Equivalence of Boolean expressions
A5	Combinational logic circuits
A6	Flip-flops
B1	Voltage dividers and multimeters
B2	The oscilloscope
B3	Diodes and rectifiers
B4	Introduction to bipolar transistors
B5	Op amps – open-loop operation
B6	Op amps – closed-loop operation

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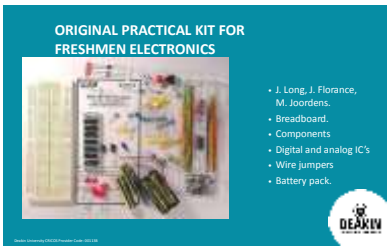

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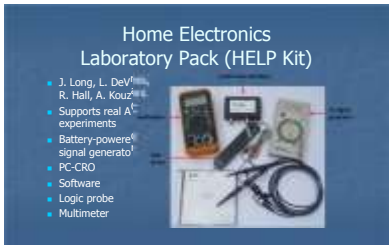

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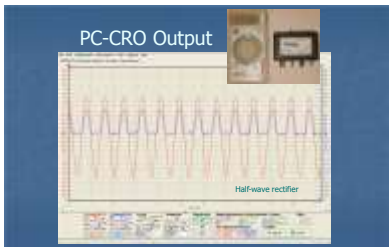

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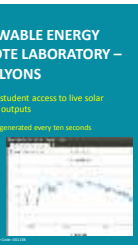
REMOTE-CONTROLLED LAB EXPERIMENTS

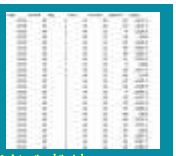
- Some success in early years.
- Abandoned with the introduction of residential schools in 2005.
- There have been great advances in remote labs outside Deakin.

Slide 32

RENEWABLE ENERGY REMOTE LABORATORY – LIAM LYONS

- Provide student access to live solar inverter outputs
  - Energy generated every ten seconds
  - Watts
  - Joules





- Automatic updating in browser
- Access to all logged data over past two years
- Accessible from both computers and mobile devices

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WEB-BROADCASTING OF LAB CLASSES

- Using *E-live* web-conferencing software to broadcast a lab class in real time to off-campus students.
- Applied in engineering physics and materials science.
- Early trials were very successful.

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Unit	Activity
Physics	Introduction to Microsoft Excel
Physics	The simple pendulum and measurement uncertainties
Physics	Rotational inertia of a flywheel
Physics	Viscosity of a fluid
Physics	Springs and Hooke's law
Physics	Standing waves on a wire
Materials	Electrical resistivity of metals



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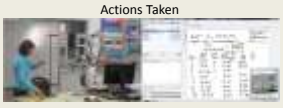
Actions Taken



- In 2012, we used the *E-live* platform to "web-cast" six physics practicals and one materials practical to distance students.
- We hoped students would be able to collect their own data from the video transmission.
- Participants were surveyed afterwards on the effectiveness of the broadcasted lab sessions.
- Prac reports were marked and the rubrics were identical for both on-campus and off-campus.

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Findings, impacts and outstanding issues

Table 2: Average report marks for the students in physics.

Semester 2012	Total on-campus assessed	Total off-campus hands-on assessed	Total off-campus *E-live* assessed	Avg. marks/10 on-campus	Avg. marks/10 off-campus hands-on	Avg. marks/10 off-campus *E-live*
Int	199	97	0	6.7	6.8	0.0
Summer	0	14	10	-	6.4	6.9
Total	199	111	14	6.7	6.8	7.1

Table 3: Average report marks for the students in materials.

Semester 2012	Total on-campus assessed	Total off-campus hands-on assessed	Total off-campus *E-live* assessed	Avg. marks/10 on-campus	Avg. marks/10 off-campus hands-on	Avg. marks/10 off-campus *E-live*
Int	119	25	12	17	19	20
Summer	0	16	8	-	19	20
Total	119	41	20	17	19	20

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Findings, impacts and outstanding issues

- A total of 34 students attended practicals by means of web-conferencing, out of a total of 380 students, over three semesters.
- The students who attended the *E-live* practicals and submitted reports, on average, obtained higher marks (~6%) than the students who performed the experiments hands-on.
- In general, the feedback from the *E-live* students was very positive. They were grateful that it was not necessary to travel to Geelong from interstate to perform the practicals.
- It was difficult to show the lab apparatus and instruments in detail, especially since the webcam was fixed in place. Higher quality video is needed.
- The experiment "Vibrations on a Wire" was unsuitable for live broadcasting by means of the existing video resolution and transmission speed.
- Students were not able to collect their own data as the experiments progressed. The demonstrators were required to write the data down on the whiteboard.
- Voice and sound transmission was not a problem.
- Students needed encouragement to participate in the session rather than merely watching.
- All students asked for the session to be recorded.
- Next step: offer *E-live* practical sessions to new cohorts of students, improve the presentation, and obtain more-detailed feedback.
- Numerous implications exist for education practice in both engineering and other fields of science.

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INTENSIVE RESIDENTIAL SCHOOL

- Introduced in 2005 in response to accreditation requirements set by Engineers Australia.
- Students attend one week of intensive residential classes for each semester of full-time study.

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LAB EXPERIMENTS 2013-2015

Table 1: Lab experiments assigned in first-year engineering physics

Experiment	Title	Source/Reference
1	Introduction to Microsoft Excel and measurement uncertainties	(Bloch, 2008; J.D. Wilson, 1998)
2	The simple pendulum and Hooke's law	(Loyd, 1997)
3	One-dimensional motion and the inclined plane	(PASCO Scientific)
4	Projectile motion	(PASCO Scientific)
5	Friction	(PASCO Scientific)
6	Collisions	(PASCO Scientific)
7	Rotational inertia of a flywheel	(Hickman, & Flint, 1961)
8	Standing waves on a wire	(Hamley, Rawnsley, & Walker, 2008)

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LAB EXPERIMENTS 2004-2012

Table 1: Lab experiments assigned in first-year engineering physics.

Experiment	Activity
1	Introduction to Microsoft Excel
2	The simple pendulum and measurement uncertainties
3	Rotational inertia of a flywheel
4	Viscosity of a fluid
5	DC electric circuits
6	The capacitor and the RC circuit

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STUDENT WORK: PROJECTILE MOTION

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CENTRIPETAL FORCES

Centripetal force from m2 and tension in the string supports the weight of mass m1.

$$\frac{m_1 v^2}{r} = m_1 r\omega^2 = m_2 g$$

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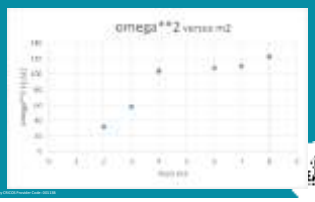
CENTRIPETAL FORCES



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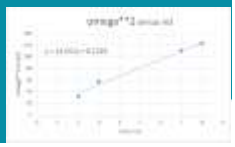
CENTRIPETAL FORCES

$$g = m_1 G r = 1(14.55\ \mathrm{s}^{-2})(0.7\mathrm{m}) = 10.1\ \mathrm{m/s}^2$$

$\text{slope} = 14.55\,\mathrm{s}^{-2} = G$



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A Remote Radioactivity Experiment

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THE LABSHARE INSTITUTE

- http://www.labshare.edu.au/

"The Hydroelectric Energy rig demonstrates the basic principle of the conversion of kinetic energy of flowing water into electrical energy, via the rotation of a turbine (Pelton wheel) connected to an electric generator."

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THE LABSHARE INSTITUTE

- http://www.labshare.edu.au/

"This rig is designed to familiarise students with signal generators and oscilloscopes in a controlled environment before using the actual devices in a hands-on lab."

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FARLABS - FREELY ACCESSIBLE REMOTE LABORATORIES

- https://www.farlabs.edu.au/

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FARLABS

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FUTURE CHALLENGES

- Shifting engineering curriculum (all courses, we hope!) to design-based learning (DBL).
- Centre for Advanced Design in Engineering Training (CADET) – a new building, a new approach in teaching.
- Replace lecture rooms with studios.
- Applying the CADET and DBL principles to off-campus teaching. (very big job!)
- Flipping the classroom (Cloud-based teaching). Replacing lectures with videos and other resources for delivering primary content. Class time for applications and problem solving.
- Cloud-based teaching will blur the line between on-campus and off-campus teaching.

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CONCLUSION

"I believe that this is most beneficial to off-campus students. To come down for a day from Sydney I start at 5 am and I buy a train ticket to the airport at $12.50. Then a plane ticket for up to $220. To get from the airport due to poor local infrastructure I have to hire a car for $100. Last time I went down to campus the flights were delayed by 3 hours due to fog and I nearly missed the prac all together. With the workload in my job I find it difficult to get time off. With the *E-live* prac I could log in and participate. This is in the true spirit of off-campus learning, which is the learning format that I have chosen."

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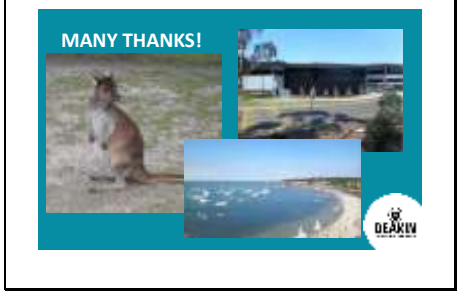

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