


<table>
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<tr>
<th>Lecture (s)</th>
<th>Topics</th>
<th>Readings</th>
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<tr>
<td>1. Introduction</td>
<td>Problems at Global Scale Connection to humans IPAT Population growth Affluence Technology Data Requirements Role of Mfg</td>
<td>Ashby Ch 11 Waggoner &amp; Ausubel (2002)</td>
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<td>4. Sustainability</td>
<td>(Discussion) Alternative points of view: Economics Eco-systems services Collapse Panarchy</td>
<td>Garrett Hardin Dasgupta Browzewimmer Hunt</td>
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<td>5. Life Cycle Assessment</td>
<td>Eco-Audit Process LCA EIO LCA Examples</td>
<td>Ashby Ch 3, see Ch 7 &amp; 12 as references Hendrickson, Lave, Matthews Ch. 1, 2, 5, 6</td>
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| 6. Renewables | Guest Lectures:  
PV: Adam Lorenz  
Wind: Paul Sclavounos  
Nuclear: Jacopo Buongiorno | Ashby Ch.10  
Smil, p. 196-210  
[164-176]renewables |
|---|---|---|
| 7. Climate Change | Guest Lecture:  
Kerry Emanuel | Smil p. 27-34 solar radiation |
| 8. Analysis Boundaries | LCA examples, comparisons, and accuracy | PV LCA  
Plug-in LCA |
| 9. Energy/Exergy | Thermo review  
Exergy  
Exergy Examples | Smil Ch 1 (skim) p 18-19  
[15,16]  
deSwaan Arons Ch 2, 6  
Szargut Exergy Table |
| 10. Materials Production | Thermo of Separation,  
Mining, Reduction, Exergy (Ellingham diagram), Ex. (Alu, Copper, Steel, Gold) | Ashby Ch. 6  
Daniels & Albery Ayres & Masini  
Ellingham diagram  
Bath University Report |
| 11. Coal | (Discussion) | Freese Ch. 1-9 |
| QUIZ I | | |
| 12. Manufacturing | Processes, physical exergy degree of perfection $\eta_p$  
Thermal efficiency  
Factories | Gutowski & Sekulic Ch6  
Williams (2002)  
Thieriz (2006)  
Branham (2010)  
Allwood (2010) |
| 13. Efficiency & Growth | Efficiency trends for 10 activities, lighting (Tsao), lifestyle (ELSA), over laps with Use Phase below | Dahmus & Gutowski  
Herring  
Tsao  
ELSA |
| 13. Use – many useful values given in lecture ppt | Transportation, autos, air travel, walking vs. riding. Buildings: heating and cooling, appliances, clothing | Smil Ch. 5  
Ashby Ch 9.5 & 9.6  
Riding and Walking, Notes  
Gutowski  
Cohen & Heberger |
| 14. End of Life | Landfill  
Incineration  
Recycle  
Remanufacture | Craighill (1996)  
Gutowski Ch4  
Ashby Ch 4  
Gutowski (2011)  
Porter Ch 9 (2002) |
| 15. Energy Transition | Efficiency, Behavior and Energy Supply | Ayres, Crossing the Energy Divide Ch 1-4  
Smil, Energy at the Crossroads Ch 6 |

Note that Readings in **Bold** are required readings. Non-bold readings add background for the curious.