# Course outline

## Part 1: Introduction to environmental impacts and interactions, foundations of Circular Economy

1. Introduction – main issues and problems of pollution and resource depletion
2. Natural resources and their natural storages – circularity of extraction, use and discharge
3. Circular Economy principles and strategy
4. Global energy and (virtual) water flows – the scale of the flows and the problems
5. Sustainability – definition, components, and metrics
6. Life Cycle thinking and the LCA framework
7. The Environmental Performance Strategy Map
8. Direct, indirect and total effects
9. Measuring environmental sustainability

## Part 2: Environmental Footprints – Introduction, definitions, implementation

10. General footprint principles and concepts
11. GHG (Carbon) footprint
12. Water footprint
13. Energy footprint
14. Nitrogen footprint
15. Ecological footprint
16. Other footprints
17. Virtual footprints
18. Measures and degrees of freedom to reduce footprints – resource saving via the resource/waste hierarchy, renewables, $CO_2$/carbon sequestration

## Part 3: Methods for Energy Saving and GHG/Haze Footprint Minimisation

19. Examples and case studies
20. Introduction to Heat Integration and Pinch Analysis
21. Advanced Process Integration Techniques – Heat Transfer Intensification, Locally-Integrated Energy Systems, integration of renewable energy sources, process-specific heat transfer properties in Total Site Heat Integration, accounting for preheating in steam generation, Power Pinch Analysis

22. Energy storage for handling supply and demand variations
23. GHG and Haze Footprint Minimisation

## Part 4: Methods for Reduction of Water Footprint, Water-Energy-GHG Nexus

24. Data extraction for Water Integration
25. Water network design using Water Pinch Analysis
26. Design for Maximum Water Reuse for Single Contaminant
27. Source/Sink Composite Curves
28. Significance of the Water Pinch
29. Water network design/retrofit (Cost Effective Minimum Water Network)
30. Reversal of the WEN – using it as a synergy mechanism