Version LR/1

EGT2
ENGINEERING TRIPOS PART IIA

Friday 8 May 2026 14:00 to 15:40

Module 3E11

ENVIRONMENTAL SUSTAINABILITY AND BUSINESS

*Answer not more than **two** questions.*

All questions carry the same number of marks.

*The **approximate** percentage of marks allocated to each part of a question is indicated in the right margin.*

*Write your candidate number **not** your name on the cover sheet.*

STATIONERY REQUIREMENTS
Single-sided script paper

SPECIAL REQUIREMENTS TO BE SUPPLIED FOR THIS EXAM
None

10 minutes reading time is allowed for this paper at the start of the exam.

You may not start to read the questions printed on the subsequent pages of this question paper until instructed to do so.

You may not remove any stationery from the Examination Room.

1 Scientific evidence indicates that Earth has crossed multiple planetary boundaries and that we are living in an environmental poly-crisis encompassing climate change, biodiversity loss, land use issues and more.

(a) Describe the concepts of planetary boundaries, doughnut economics, planetary health (check) and tipping points. Summarise which types of boundaries have been exceeded, whether tipping points have been reached, and explain why this matters for firms involved in global supply chains. [40%]

(b) Define and differentiate between ecological footprint, carbon footprint, and carbon inequality. Discuss the advantages and limitations of footprint concepts in general. Consider the implications of these opportunities and limits of footprint concepts. For a typical engineering firm (choose a real or fictive example), explore how these indicators can help map environmental impacts across Scopes 1–3 and identify critical areas for action ("hotspots"). [40%]

(c) Select one sector (e.g., aviation, construction, digital services, or agriculture) and critically evaluate how the planetary boundaries framework could guide long-term strategy for companies within that sector. [20%]

Question 1 (*covers Sessions 1 and 2*)

(a)
Key points:

- Sustainability as system condition: economy embedded in society, embedded in biosphere; businesses depend on and shape these systems
- Planetary boundaries: biophysical limits (e.g. climate, biosphere integrity, freshwater, land-system change, biogeochemical flows, novel entities, etc.) within which humanity can operate safely (Richardson et al.).
- Raworth's Doughnut: inner ring = social foundation (e.g. food, health, education, equity, voice); outer ring = ecological ceiling (planetary boundaries). Safe and just space = between rings.
- Builds on planetary boundaries but adds social justice and human development.
- Tipping points: According to the Intergovernmental Panel on Climate Change (IPCC), tipping points are 'critical thresholds in a system that, when exceeded, can lead to a significant change in the state of the system, often with an understanding that the change is irreversible.' Climate tipping points are elements of the Earth system in which small changes can trigger reinforcing

loops that 'tip' the system from one stable state into a profoundly different one. The tipping point is reached for warm water corals.
- Planetary health: human health and civilisation depend on healthy natural systems; links environmental degradation to human well-being.
- "Planetary Health Check": Earth beyond six of nine boundaries (e.g. climate, biosphere, land, freshwater, biogeochemical flows, novel entities).

(b)

- Ecological footprint vs carbon footprints: consumption-based indicators; ecological footprint in global hectares; carbon footprint in tonnes (CO_2e) per person/household/firm.
- Carbon inequality: highly skewed emissions; top income groups responsible for disproportionate share; implications for fairness and policy.
    - Science-based targets; internal carbon pricing; switching to renewables; demand-side measures (efficiency, sufficiency).
    - Value-chain interventions (scope 3); low-impact product design; circular practices; sustainable sourcing.
- Personal footprint calculators (e.g. CoolClimate, WWF, Global Footprint Network) and how they reveal hotspots for action.

Strengths of footprint approaches:

- Make abstract global limits tangible; enable benchmarking and target-setting;
- support communication and accountability.

Limitations:

- Data gaps & assumptions; system boundary choices; uncertainty in scope 3.
- Risk of individualising responsibility; ignoring structural drivers.
- Potential for rebound effects (efficiency gains → more consumption).

Implications for engineers:

- Use footprints as diagnostic tools, not precise "truth"; triangulate with other indicators (health, equity, resilience).
- Integrate into design briefs (LCA, carbon budgets) and corporate strategy, but remain critical and transparent about assumptions

(c)

Sectors, boundary crossings, and strategies:

- Energy: fossil fuels → climate boundary (GHGs), aerosol loading. Strategy: decarbonize and make production more efficient

- Food/agriculture: land-use change, biodiversity loss, nitrogen & phosphorus cycles, freshwater use. Strategy: Invest in regenerative agriculture and circular economy
- Transport / aviation / shipping: high fossil fuel use, non-CO_2 effects. Strategy: Invest in alternative fuels, high-efficiency vehicles, EVs
- Digital: data centres energy demand, minerals extraction, e-waste. Strategy: invest in less energy intensive software and hardware

2 Sustainable investing is reshaping capital allocation and altering how investors view sustainability-related risks and opportunities.

(a) Describe how institutional investors and asset managers use ESG information in portfolio development and stewardship. Distinguish between risk-based ESG integration, exclusionary screening, and impact-focused investing. [30%]

(b) Consider the four example companies covered in class. Each has a different combination of financial performance and ESG traits (e.g., strong "E" but weak "S", strong "S" but high carbon intensity, excellent disclosure but mediocre actual performance, etc.). Explain how various sustainable investors might rank these companies from most to least investable. Discuss the value trade-offs and ethical dilemmas involved. Relate your response to the pre-class "Would You Invest In…?" sustainability dilemma exercise.

Focus on explaining the mechanisms and key drivers that influence how investors rank companies based on ESG criteria. Your answer should detail the underlying factors and processes that shape these rankings. You are not asked to rank the companies.

As a reminder: The four companies listed in the pre-assignment are as follows:

SolarTech Inc. (Designs and sells affordable solar panels, manufactures in a country with poor labour rights enforcement, recently accused of worker health violations at one supplier factory).

GreenBanc (Finances low-carbon infrastructure, holds equity in fossil fuel companies to influence them from within, has no board diversity policy or public gender data).

AgroGrow (Uses regenerative farming techniques and pays fair wages, operates in monoculture regions with high water usage, has poor carbon disclosure ratings).

MetaFit Corp (Popular fitness app company with a carbon-neutral data centre policy, uses AI that collects sensitive user data without clear consent, is a major investor in youth mental health charities. [40%]

(c) Critically assess the potential and limitations of sustainable investing as a catalyst for decarbonising the real economy and fostering social change. Under what circumstances can ESG-oriented capital markets speed up the sustainability transition, and when might they merely rebrand existing practices or shift risks without reducing them? Support your argument with examples. [30%]

Question 2 (*covers Session 5, partly Session 3*)

(a)

- ESG integration: systematically incorporating ESG factors into financial analysis to adjust risk/return; not necessarily changing the investment universe.
- Screening: excluding "bad" sectors/companies (negative) or preferring "good" ones (positive/best-in-class).
- Impact investing: intentional pursuit of measurable positive social/environmental impact alongside financial return, targeted sectors like renewable energies, and the conversion rate between value and values.
- Drivers: climate and transition risks; reputational considerations; client demand; regulatory expectations; evidence that sustainability can affect long-term performance (Eccles & Klimenko, 2019).

(b)

- Use of ESG ratings, climate scenario analysis, carbon pricing in valuation models
- Norm-based and ethical considerations, rankings reflect tensions between competing priorities
- Active ownership: shareholder resolutions, direct engagement on climate plans, social issues; voting against directors.
- Data challenges: disclosure quality and alignment with investor mandates; inconsistent ratings between providers; self-reported corporate data; lack of standardisation; risk of "rating shopping".
- Example from "Would You Invest In…?": comparing firms with different mixes of E, S, G; trade-offs (e.g. high E but poor S); how this complicates investment decisions.
- Hartzmark & Sussman (2019), as covered in the lecture slides: fund flows respond to sustainability labels/rankings, showing investor preference.

(c)

Potential:

- Lower cost of capital for sustainable firms; higher for laggards; pressure on boards; mainstreaming of climate risk.

Limits:

- Short-term performance benchmarks; herding; incomplete coverage (private firms, small caps); free-rider problems.
- Regulatory uncertainty; political backlash against ESG.
- Markets can reallocate capital but cannot by themselves change underlying policies, infrastructure, or social norms.

Implications for engineers/managers:

- Need robust project business cases and quantification of sustainability benefits.

Engage with investors to explain transition plans; align technical roadmaps with credible financial narratives.

3 Businesses are increasingly applying behavioural insights to create more environmentally friendly products, processes, and workplaces.

(a) Define nudging and choice architecture as used in behavioural economics. Explain how "behaviourally informed interventions" differ from traditional tools such as information campaigns, pricing, or regulation. Refer to relevant literature and the UNEP "Little Book of Green Nudges" where appropriate. [30%]

(b) Propose and briefly outline five specific "green nudges" that a large organisation (e.g., a university, hospital, or engineering firm) could implement to promote more sustainable behaviour among employees or customers. For each nudge, identify the targeted behaviour, the behavioural mechanism involved (e.g., default effects, social norms, salience, loss aversion, habit disruption), and the expected environmental impact. [40%]

(c) Choose one of your proposed nudges and critically assess its effectiveness, risks, and ethical considerations. Address issues such as transparency, autonomy, distributional effects, and the potential for nudges to replace more structural changes ("nudging instead of regulating"). Under what circumstances would you regard this intervention as "nudging for good"? [30%]

Question 3 (*covers mostly Session 7*)

(a)

- Nudge (Thaler & Sunstein): any aspect of choice architecture that alters behaviour in a predictable way without forbidding options or significantly changing economic incentives; easy and cheap to avoid.
- Behavioural foundations: bounded rationality, limited attention, heuristics & biases, social norms, dual-system thinking.
- Choice architecture: how options are presented (defaults, order, framing).
- Comparison:
    - Traditional tools: taxes/subsidies (change prices), regulation (ban/mandate), information campaigns (provide facts).
    - Nudges: subtle changes to context; preserve freedom of choice; often low-cost but limited in scope.

(b)

Example nudges and mechanisms (any five):

- Green defaults: default to renewable electricity tariff, double-sided printing → status quo bias, inertia.
- Feedback and real-time information: energy use displays, CO_2 dashboards → salience, learning.
- Social norm messages: "Most people in your office recycle" → conformity, normative influence.
- Framing: gain vs loss framing of environmental messages, highlighting co-benefits (health, cost savings).
- Simplification and hassle reduction: one-click train booking; automatic enrolment in bike-to-work schemes → reduce friction costs.
- Commitment devices: public pledges, green challenges → consistency motivation.
- Choice set design: more vegetarian options at top of menu.
  Must connect each to specific behaviour and psychological mechanism.

(c)

- Design a concrete nudge (e.g. default vegetarian meals at college events; feedback on shower energy use; EV booking system at company).
- Steps: diagnose behaviour and barriers; select mechanism; run pilot/experiment; measure outcomes; iterate.
- Benefits: low cost, scalable, complements structural changes; can unlock quick wins.
- Risks/ethics: manipulation concerns, paternalism, unequal effects; potential to distract from necessary regulation or infrastructure investment; "sludge" when used to hinder sustainable choices.
- Refer to Sunstein & Reisch (2014) argument for "Automatically green" policies; possibly UNEP's "Little Book of Green Nudges".

END OF PAPER