

EGT3  
ENGINEERING TRIPOS PART IIB

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Wednesday 29 April 2015      14.00 to 15.30

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**Module 4M18**

**PRESENT AND FUTURE ENERGY SYSTEMS**

*Answer not more than **three** 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**

CUED approved calculator allowed

Engineering Data Book

**10 minutes reading time is allowed for this paper.**

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

1 (a) Carefully describe the extent of the project that would retrofit all the existing buildings in the UK by 2050 to halve their emissions of carbon dioxide from their 1990 levels, assuming:

(i) The primary sources of energy meet their own targets for decarbonising energy supplies at source. [25%]

(ii) The primary sources of energy do not meet their own targets for decarbonising energy supplies at source. [25%]

(b) Describe the strengths and weaknesses of the current first generation of renewable energy sources for powering the world of 2050, with regard to both dense megacities and remote rural communities. [50%]

2 (a) Write down the *Kaya identity* and briefly describe the emissions mitigation strategies implied by its four terms. [25%]

(b) Assuming the population of the UK remains fixed and using practical examples to illustrate your answer, compare the technological readiness and political acceptability in the UK of the mitigation strategies given in your answer to (a). [40%]

(c) With reference to work by Shell, National Grid or more generally, describe the purpose of scenario planning and its use in describing the next 40 years in the context of the sourcing and use of energy in the world. [35%]

3 (a) Describe methods that are used to balance supply and demand in a conventional power system at different timescales, explaining the main features of each of these methods and how they are related. [50%]

(b) Outline the impact of a *smart grid*, with regard to frequency control, faults and storage. Your answer should include the potential benefits that can be obtained from the smart grid in each of these areas, as well as challenges that need to be addressed for implementation in each case. [50%]

4 (a) Explain why a grid connection is preferred in the transmission and distribution of electricity. Making a distinction between transmission and distribution describe briefly the sources of losses and their main characteristics. Hence discuss the importance of strategic planning and the uses of spinning reserve. [50%]

(b) Scotland has large nuclear, coal-fired, oil and combined cycle gas turbine power stations and also has substantial pumped storage power stations. National Grid operates two AC transmission lines across the Scottish border to England, which transmit power from the power stations in Scotland to England. Scottish Power pays National Grid £40M per year to connect the Longannet coal-fired station to the grid. Scottish Power Transmission have joined with National Grid to build the Western HVDC link, Hunterstone to Deeside, as shown in Fig. 1. The link comprises 384 km of subsea HVDC cable and around 33 km of land based HVDC cable to the southern terminal. Around 3km of AC cable connects the southern terminal to the grid. Making reference to the technical and commercial issues, describe the benefits of such a scheme and account for the features mentioned above. [50%]



Fig. 1

**END OF PAPER**