ENGINEERING TRIPOS PART IIB

Monday 30 April 2012 2.30 to 4

Module 4B18

ADVANCED ELECTRONIC DEVICES

*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.*

There are no attachments.

STATIONERY REQUIREMENTS
Single-sided script paper

SPECIAL REQUIREMENTS
Engineering Data Book
CUED approved calculator allowed

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

mjk03

1 (a) Sketch the conduction band-edge energy diagrams for multilayer structures containing heterojunctions between (say) GaAs and $Al_{0.3}Ga_{0.7}As$ as they would be used to

(i) generate hot electrons,
(ii) achieve quantum confinement of electrons and holes,
(iii) allow tunnelling of electrons and
(iv) allow resonant tunnelling of electrons.

In each case, annotate your diagrams with details of layer thicknesses and doping concentrations. [60%]

(b) Describe one device that uses each of these phenomena, and comment on the extent to which that device is manufactured. [40%]

2 Describe at least three different semiconductor multilayer devices that are used to generate microwave power between 30 GHz and 100 GHz. In each case comment on the key design aspects of the semiconductor multilayers needed to achieve an effective device. Compare and contrast the performance of these devices in terms of efficiency, noise, temperature dependence, manufacturability and cost. [100%]

3 The Schottky barrier, the planar-doped-barrier diode, the ASPAT diode and the Ge backward diode are four devices that can be used to detect microwaves.

(a) What is the common feature of these devices that allows microwaves to be detected? Describe the relevant key figure of merit of an effective detector. [20%]

(b) Describe the operating principles of each diode. [30%]

(c) Compare and contrast their performance as detectors in terms of efficiency, noise, temperature stability, dynamic range, frequency range of operation, and manufacturability etc. [50%]

4 (a) Describe the modern methods for growing the semiconductor multilayers used for making advanced microwave devices. [50%]

(b) In each case describe two ways of determining

(i) the thicknesses,
(ii) the composition and
(iii) the doping levels,

of key layers in the multilayer structure. [50%]

5 Discuss, with annotated examples, the possibility of intrinsic low-cost unmanufacturability of nanostructures that are proposed as advanced electronic components. [100%]

END OF PAPER