Department of Electrical and Computer Engineering
UNIVERSITY OF BRITISH COLUMBIA

EECE 480 SEMICONDUCTOR DEVICES

FINAL EXAM, December 12, 2002

Time: 2.5 hours
Answer 4 (FOUR) questions.
All questions carry equal weight.
No notes, calculators or books allowed.
This exam consists of 2 pages

1. BJT

(a) Describe how high-value resistors can be obtained in a compact fashion in a traditional BJT process.

(b) Why is "Electrostatic Discharge" an issue in bipolar circuits, and how can it be protected against in a technology such as GA911 ?

(c) Describe the physical phenomena in a BJT that are represented by the SPICE parameters: VAF, ISE, NE, IKF.

(d) What is storage capacitance in a BJT, and how is it represented in SPICE?

2. Scaling

(a) Describe the effect that vertical scaling has had on the modeling of the collector current in bipolar transistors.

(b) Describe the effect that vertical scaling, doping scaling, and voltage scaling has had on the sub-threshold current of MOSFETs.

3. Digital Logic

(a) Sketch an ECL NOR/OR gate, complete with current mirror and, if you wish, output emitter followers.

(b) – *(i)* Why is ECL so fast?
– *(ii)* Why is ECL faster than TTL?
– *(iii)* Why is ECL faster than CMOS?

4. Mobility

(a) – *(i)* Sketch the energy band diagram (vacuum level, E_C, E_F and E_V) of a Si/SiGe HBT under: *(1)* equilibrium conditions; *(2)* forward bias.
– *(ii)* Is mobility an important issue for this device? If so, what factors affect it?

(b) – *(i)* Sketch the potential profile (preferably 2-D) of a Si MOSFET above threshold.
– *(ii)* Is mobility an important issue for this device? If so, what factors affect it?

(c) For one of the devices in this question, show how the mobility could be measured.

5. MOSFET

(a) What are the factors affecting $f_{\max}$ for a MOSFET?

(b) The figure of a "Terahertz Transistor" comes from INTEL's promotional literature.
Describe how the features illustrated in the figure contribute to making this transistor a possible contender to the HEMT for the title of "world's highest frequency device".