Examination Feedback for EEE6206 – Power Semiconductor Devices
Spring Semester 2015-16

Feedback for EEE6206 Session: 2015-2016

Feedback: Please write simple statements about how well students addressed the exam paper in general and each individual question in particular including common problems/mistakes and areas of concern in the boxes provided below. Increase row height if necessary.

General Comments:

In general, candidates scored well in the examination. Compared to previous iteration, this exam was written with a lower score weighting for analytical calculations, which reduced the average score per question, so that a pass mark was not achieved by analytical questions alone. This was especially so with basic semiconductor questions which included some questions directly aimed towards properties of semiconductors for power devices. Some further clarity is required on a few questions where more than one solution were submitted by students. The next exam paper would need to increase the difficulty of questions 1 and 6 as the average marks are slightly high.

Question 1:

Majority of candidates attempted this question. The majority of candidates misunderstood the requirements of Q1a and answered in terms of an n type high voltage devices (i.e. the presence of a drift region) and not the electrical properties of a device if it was constructed in n or p type silicon.

Identifying devices with and without conductivity modulation and contrasting/comparing switching and on state characteristics of devices with/without conductivity modulation was answered well. Some candidates failed to describe the mechanism of conductivity modulation and were confused between reverse recovery and tail currents by incorrectly tagging reverse recovery to IGBT type devices.

Majority of candidates scored well with the hall effect calculation. If this question is to be repeated in the future, the question needs to specify that mobility is unknown and intrinsic carrier concentration as various ways were given to achieve an answer.

Question 2:

Majority of candidates provided correct drawings for impaction ionization; however few used the figure to describe the process.

Reverse recovery was correctly answered in terms of the current time curve. Some candidate could not produce the voltage time curve and link reverse recovery and peak voltage.

Majority of the candidates answered the analytical questions well (2c-d). Question 2d needs to specify that substrate doping concentration is required as an output as there are two methodologies to obtain the answer (one requiring more work).

Question 3:

Majority of the students correctly answered 3a, showing the effect of barrier height on n type and p type substrates. Some candidates only supplied one characteristic and not a true comparison.

Majority of the students miss understood 3b and did not compare/contrast a silicon carbide pin and Schottky diode, decided to compare silicon pin to silicon carbide Schottky. Possibly re-phrase the question to include the material type before the diode type to clarify.

Q3c correctly answered, however not all students provided workings making their solutions hard to follow, needs reinforcing in lectures and tutorials.

Q3d caught some students out by asking for a p type Schottky diode, majority answered the question well. Students found the question easy, reduced weighting of question if used in future iterations

Question 4:

The majority of students correctly showed the transistor connected in common emitter configuration, some dis-regarded the voltage polarity or incorrectly showed the transistor operating in common base.

Correct drawings of common base connected transistor, correctly identified regions. Could consider using this question for a NMOS or IGBT for differentiation.

Some missed the dependency of depletion region and transistor gain and its relationship with breakdown voltage. Majority correctly answered the basic breakdown mechanism even if the relationship was not given.

Transistor gain equation has an incorrect formula in the paper compared to notes/mark sheets. Hyperbolic functions were not included in the formula sheet; majority of candidate supplied the correct answer with information given.

Some students were caught out with the last part of 4e and not showing electric field distribution for both structures and not indicating that the breakdown voltage would be higher for NPT. Possibly re-phrase the question to ask for the electric field profile and specify for infinite drift region thickness of the NPT device.

Question 5:

Majority of candidates correctly drew the MOSFET cross-section; the only mistakes came from the gate definition and the vicinity of the p base. Reduce weighting for this type of question in future iterations due to its difficulty level.

Majority of answers failed to include reduced cell dimensions as a benefit of trench FETs. Majority of answered gave answers comparing electrical characteristics and not the cause. Possibly rephrasing of the question is required.

Some candidates failed to provide drawings of the device cross-section for linear and saturation. Descriptions of the process mainly regarded velocity saturation and did not link gate drain voltage differential to saturation and pinch off.

Analytical questions were answered o.k. Majority of the candidates failed to answer the resistance calculation in terms of specific on-state resistance.

Question 6:

On state characteristics of IGBT and MOSFETs given o.k. Majority of the candidates correctly showed the switching characteristics, some showed the IGBT with a reverse recovery during turn off.

Metal oxide semiconductor band diagram correctly produced by all students. This question need a reduced weighting if used in future iterations.

Gate oxide thickness calculated correctly. Some candidates didn't show clear working which need to be re-enforced during lectures/tutorials. Drift region calculation needs to specify substrate doping as a parameter, as solution is obtained through more than one method. Some candidates misunderstood the final result by the summation of the diffusion length and maximum depletion width.

Question 7:

Question 8: