Power Devices and Systems

Lecture Test Material Scope and Reference Materials (2nd through 5th Sittings)
2018/19 Academic Year

References

[1] Benda V., Gowar J., Grant D. A.: *Power Semiconductor Devices: Theory and Applications.* Wiley, 1999.
- Chapter 1 = Manual 0, Refs. I and J
- Chapter 2 = Manual 0, Ref. KLMN
- Chapter 3 = Manual 0, Ref. H
- Chapter 5 = Manual 1, Ref. ABCDE
- Chapter 10 = Manual 3P, Ref. ABC

[2] Rashid M. H. (ed.): *Power Electronics Handbook.* Academic Press, 2001.
- Chapter 6 = Manual 0, Ref. EG

[3] Mohan N., Undeland T. M., Robbins W. P.: *Power Electronics: Converters, Applications, and Design.* Wiley, 2003.
- Chapter 20 = Manual 1, Ref. FG

Note. *As far as the 2nd sitting is concerned, the above references should be regarded as complementary. You may refer to them to clarify doubtful issues but in the test, there will be no problems that would not be covered in lecture.*

Theoretical Problems

1. Introductory topics; the semiconductor switch
   - lecture
   - [2] Section 6.3

2. Voltage blocking and current conduction
   - lecture
   - [1] Sections 2.1.2, 2.1.3; [3] Section 20-3: what a phenomenon generally consists in and what consequences it has for a semiconductor device; basic relationships between physical quantities and structure parameters but without precise formulae
   - [1] Sections 1.3.1, 1.5; Section 3.1 excluding sub-sections; Section 5.1: as above, emphasising basic differences between unipolar and bipolar devices

3. Power diodes
   - lecture
   - [1] Sections 3.1.1, 5.1, 5.2, 5.3 (including sub-sections), without formulae

4. VDMOS power MOSFET
   - lecture
   - [1] Sections 10.1, 10.2 (including sub-sections), without references to energy bands
     For the 2nd sitting, skip details of cell structures such as Figs. 10.4, 10.7, 10.8 and corresponding text.

- [1] Sections 10.3.1, 10.3.2, considering resistive load, without formulae
  MOSFET switching with resistive load was explained in lecture so this is merely a complementary source; it only covers resistive load in text, not in figures; for waveforms see Fig. 6 in Manual 3[A].
- [1] Section 10.4, without details: what a phenomenon generally consists in and what consequences it has for the semiconductor device

Note:

- *the only formulae required to be known are basic electrical and electronic engineering ones*
  e.g. Ohm's Law is required but not the formula for space charge region width
- *however, conclusions from these formulae and phenomena described by them are required to be known*
  e.g. increasing voltage applied causes the space charge region to extend
- *no formula derivations are required*
- *no detailed schematic diagrams nor graphs are required*
  e.g. Figs. 10.6(b) or 10.7 in [1]
- *however, schematic diagrams and graphs showing circuit ideas and key relationships are required*
  e.g. Figs. 10.10 and 10.11 in [1]

Computational Problems

1. Breakdown voltage, punch-through voltage, voltage capability; electric field distribution in the lightly doped layer (plot)
   - lecture

2. On-state resistance and voltage drop across a unipolar and a bipolar device
   Bipolar devices are excluded from the 2nd sitting.
   - lecture (unipolar)
   - [1] Section 5.1 (bipolar), especially Eq. 5.13 and formulae for parameters involved

3. Switching speed of unipolar and bipolar devices
   - lecture

Note. *Formulae are not required to be known; however, an understanding of what relationships they represent as well as when they can and how they should be applied, is.*
Problems may be formulated in various ways, including given and unknown data different from those found in the examples analysed in lecture.