DSE Electives:

Guide to Electives for Distributed Systems Engineering students

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Purpose of this Guide

- DSE students usually study **4 semesters**

1st semester	→	attending **mandatory** courses
4th semester	→	writing **master thesis**
2-3 semesters	→	taking **electives & internship** ??

Purpose of this Guide

- Many students get **confused** by **electives & internship**
  - need 60 credits altogether, i.e., **30 credits/semester**
  - electives are **very different** → how to suit your needs?
  - electives are **composed of** several „units“
    - **lectures, exercises, labs**
    - some **in summer**, some **in winter**

Purpose of this guide:

overview of electives and possible paths in 2 semesters

(up-to-date version at https://bitbucket.org/dimakuv/dse-electives-internship-guide)

You need 60 Credits

60 credits

electives: 48 credits

[E1]	ASC: Advanced Security and Cryptography	6
[E2]	WSN: Wireless Sensor Networks	6
[E5]	IS: Selected Areas of Internet-based Systems	12
[E10]	AD: App Development for Mobile & Ub. Comp.	6
[E4]	CBSE: Component-based SW Engineering	6
[E12]	FCL: Foundations of Computational Logic	9
[E3]	DOS: Distributed Operating Systems	6
[E8]	MOS: Microkernel-based Operating Systems	6
[E9]	RTS: Real-Time Systems	6
[E6]	CDS: Concurrent and Distributed Systems	12
[E7]	SFT: Software Fault Tolerance	15
[E11]	PODS: Principles of Dependable Systems	9
[E13]	ATSA: Advanced Topics in Systems Arch.	*
[E14]	ATDS: Advanced Topics in Distributed Systems	*

internship: 12

[1]	Lab: SFT	6
[2]	Lab: CDS	6
[3]	Lab: SE	6
[4]	Lab on Networks	6
[5]	Company	6
[6]	Small thesis	12

see also here

* – number of credits depends on courses taken

Be Careful! Module Conflicts!

- *E5* includes the same courses as *E2* and *E10*
- so if you take *E2* **and** *E10*, you **cannot** take *E5* (because of the conflicts of courses)
- but you can take *E2* **and** *E5* without *E10*
- or you can take *E10* **and** *E5* without *E2*

[E2] WSN: Wireless Sensor Networks 6
[E5] IS: Selected Areas of Internet-based Systems 12
[E10] AD: App Development for Mobile & Ub. Comp. 6

[E4] CBSE: Component-based SW Engineering 6

[E12] FCL: Foundations of Computational Logic 9

[E3] DOS: Distributed Operating Systems 6
[E8] MOS: Microkernel-based Operating Systems 6
[E9] RTS: Real-Time Systems 6

[E6] CDS: Concurrent and Distributed Systems
[E7] SFT: Software Fault Tolerance
[E11] PODS: Principles of Dependable Systems

[E13] ATSA: Advanced Topics in Systems Arch.
[E14] ATDS: Advanced Topics in Distributed Systems *

[1] Lab: CDS 6
[2] Lab: SFT 6
[3] Lab: SE 6

[4] Lab on Networks 6

[5] Company 6

[6] Small thesis 12

- *E6* and *E7* include the internship labs *1* and *2* correspondingly
- So if you take, for example, *E6*, you **cannot** take lab *1* (and the other way around)

Possible Paths: what suits your needs?

- Generally, you can follow these paths:
  (but of course, you can choose your own mix of modules)

Balanced Path
- *focus*: a bit of everything
- internet, mobile, security, parallel/distributed systems
- emphasis on SW practice

Networks Path
- *focus*: Wide/Local Area Networks
- internet, sensors, security, mobile, distributed systems
- emphasis on SW practice

Fault Tolerance Path
- *focus*: SW bugs / HW glitches
- dependable/fault tolerant systems, distributed systems, OS
- emphasis on low-level SW/HW

Operating Systems Path
- *focus*: Operating Systems (OS)
- operating (real-time, distributed) systems, parallel systems
- emphasis on low-level SW

Theory Path
- *focus*: SW theory
- security, software engineering, compilers, logic, real-time
- emphasis on theory/algorithms

Electives: Overview

[E1] ASC: Advanced Security and Cryptography 6

[E2] WSN: Wireless Sensor Ne
[E5] IS: Selected Areas of Inter
[E10] AD: App Development fo

[E4] CBSE: Component-based

[E12] FCL: Foundations of Com

[E3] DOS: Distributed Operati
[E8] MOS: Microkernel-based
[E9] RTS: Real-Time Systems

[E6] CDS: Concurrent and Dist
[E7] SFT: Software Fault Tolera
[E11] PODS: Principles of Depe

[E13] ATSA: Advanced Topics in Systems Arch. *
[E14] ATDS: Advanced Topics in Distributed Systems *

Recommended for:
→ everyone

By: Chair of privacy and data security

Description:
→ Topics include ciphers for cryptographic encryption (DES, Diffie-Hellman, RSA), secret keys, different attacks via network, anonymity. Warning: a lot of theory, algorithms, and math

Includes:
→ Security and Cryptography II (lectures + exercises)
– summer semester

NOTE: orange highlightings are clickable links

Electives: Overview

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[E9] RTS: Real-Time Systems

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[E11] PODS: Principles of Depe

[E13] ATSA: Advanced Topics in

[E14] ATDS: Advanced Topics in

Recommended for:
→ networks path

By: Chair of Computer Networks

Description:
→ Many programs require input data from sensors (for example, weather conditions). Usually there are many sensors connected in one network. Topics: how to pass info between sensors? what if some sensors fail? how to efficiently place sensors?

Includes:
→ Wireless Sensor Networks (lectures + exercises)
– summer semester

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[E9] RTS: Real-Time Systems

[E6] CDS: Concurrent and Distri

[E7] SFT: Software Fault Toleran

[E11] PODS: Principles of Depen

[E13] ATSA: Advanced Topics in S

[E14] ATDS: Advanced Topics in I

Recommended for:
→ networks path

By: Chair of Computer Networks

Description:
→ How are wide-area (internet) and local-area (wireless) networks arranged. How to program mobile applications that communicate over networks.

Includes (choose any 2 of these 3):

→ Internet and Web Applications (lectures + exercises)
– summer semester
→ Wireless Sensor Networks (lectures + exercises)
– summer semester
→ App Development for Mobile & Ub. Comp. (lect + ex)
– winter semester

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[E7] SFT: Software Fault Toleran
[E11] PODS: Principles of Depen

[E13] ATSA: Advanced Topics in S
[E14] ATDS: Advanced Topics in I

Recommended for:
→ balanced path
→ networks path

By: Chair of Computer Networks

Description:
→ How to program mobile applications that communicate over networks.

Includes:
→ App Development for Mobile & Ub. Comp. (lect + ex)
– winter semester

Electives: Overview

[E1] ASC: Advanced Security and Cryptography 6

[E2] WSN: Wireless Sensor Networks 6
[E5] IS: Selected Areas of Internet-based Systems 12
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[E4] CBSE: Component-based SW Engineering 6

[E12] FCL: Foundations of Comp

[E3] DOS: Distributed Operatin
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[E9] RTS: Real-Time Systems

[E6] CDS: Concurrent and Distri
[E7] SFT: Software Fault Toleran
[E11] PODS: Principles of Depen

[E13] ATSA: Advanced Topics in S
[E14] ATDS: Advanced Topics in D

Recommended for:
→ balanced path
→ theory path

By: Chair of Software Technology

Description:
→ Building complex SW systems is challenging. One way is to build these systems from components. Lecture discusses possible ways to implement and connect these components in one system.

Includes:
→ Component-based Software Engineering (lec + ex)
– summer semester

Electives: Overview

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[E2] WSN: Wireless Sensor Networks 6
[E5] IS: Selected Areas of Internet-based Systems 12
[E10] AD: App Development for Mobile & Ub. Comp. 6

[E4] CBSE: Component-based SW Engineering 6

[E12] FCL: Foundations of Computational Logic 9

[E3] DOS: Distributed Operating
[E8] MOS: Microkernel-based Op
[E9] RTS: Real-Time Systems

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[E7] SFT: Software Fault Toleran
[E11] PODS: Principles of Depend

[E13] ATSA: Advanced Topics in S
[E14] ATDS: Advanced Topics in D

Recommended for:
→ theory path

By: Chair of Computational Logic

Description:
→ Propositional logic, equational logic; machine learning; natural-language processing. Warning: lots of math and theory!

Includes:
→ Foundations, Module No. MCL-F (lec + ex)
– winter semester

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[E10] AD: App Development for Mobile & Ub. Comp. 6

[E4] CBSE: Component-based SW Engineering 6

[E12] FCL: Foundations of Computational Logic 9

[E3] DOS: Distributed Operating Systems 6
[E8] MOS: Microkernel-based Operating Systems 6
[E9] RTS: R

[E6] CDS: C
[E7] SFT: S
[E11] PODS

[E13] ATSA
[E14] ATDS

Recommended for:
→ everyone

By: Chair of Operating Systems

Description:
→ Distributed systems are composed of many independently operating nodes (machines, CPU cores, etc.). How to orchestrate all these nodes? How to synchronize information among them? How to enforce security on remote machines?

Includes:
→ Distributed Operating Systems (lec + ex)
– summer semester

Electives: Overview

Recommended for: → operating systems path

By: Chair of Operating Systems

Description:
→ Topics include many low-level OS mechanisms: threads and concurrency, inter-process communication (IPC), device drivers, memory and resource management, virtualization, security, fault tolerance.

Includes:
→ Microkernel-based Operating Systems (lec + ex)
– winter semester

[E8] MOS: Microkernel-based Operating Systems 6

Electives: Overview

Recommended for:
→ operating systems path
→ theory path

By: Chair of Operating Systems

Description:
→ Many SW systems need to operate at real-time (transport control systems, for example). This means that computers must schedule and perform computations to meet deadlines. Theory on scheduling and the concepts on time are explained.

Includes:
→ Real-Time Systems (lec + ex)
– winter semester

[E9] RTS: Real-Time Systems 6

Electives: Overview

Recommended for:
→ everyone

By: Chair of Systems Engineering

Description:
→ Modern SW systems work on clusters of many machines/CPUs (nodes). To make these systems fast and efficient, it is necessary to parallelize work on all available nodes. This course has a mix of theory on concurrency and practical tasks on parallel programming.

Includes:
→ Foundations of Concurrent and Distributed Systems (lecture)
– summer semester
→ Lab: Concurrent and Distributed Systems
– summer semester

[E1] ASC: A

[E2] WSN:
[E5] IS: Se
[E10] AD: A

[E4] CBSE

[E12] FCL: F

[E3] DOS:
[E8] MOS:
[E9] RTS: F

[E6] CDS: Concurrent and Distributed Systems 12
[E7] SFT: Software Fault Tolerance 15
[E11] PODS: Principles of Dependable Systems 9

[E13] ATSA: Advanced Topics in Systems Arch. *
[E14] ATDS: Advanced Topics in Distributed Systems *

Electives: Overview

[E1] ASC: A

[E2] WSN:
[E5] IS: Se
[E10] AD: A

[E4] CBSE:

[E12] FCL: F

[E3] DOS:
[E8] MOS:
[E9] RTS: F

[E6] CDS: C

[E7] SFT: Software Fault Tolerance 15

[E11] PODS: Principles of Dependable Systems 9

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[E14] ATDS: Advanced Topics in Distributed Systems *

Recommended for:
→ fault tolerance path

By: Chair of Systems Engineering

Description:
→ All programs contain bugs. The more complex the program becomes, the more bugs it has. Moreover, some bugs can be very hard to diagnose and can affect people all around the world (like Skype crashes). The course covers techniques how to protect applications against SW bugs.

Includes:
→ Software Fault Tolerance (lecture)
– summer semester
→ Lab: Software Fault Tolerance
– winter semester
→ Seminar: Current Topics in Software Fault Tolerance (paper reading)
– winter semester

Electives: Overview

[E11] PODS: Principles of Dependable Systems 9

Recommended for: By: Chair of Systems Engineering
→ fault tolerance path

Description:
→ Computers can (rarely) fail not because of software bugs, but because of their unreliability: aging, manufacturing problems, bad environment conditions (high temperature or radiation). This becomes of serious concern when running SW systems on clusters of thousands of such unreliable computers. This course teaches how to cope with these problems at the hardware and software level.

Includes:
→ Principles of Dependable Systems (lectures + exercises)
– winter semester
→ Seminar: Current Topics in Dependable Systems (paper reading)
– summer semester

Electives: Overview

Recommended for: By: Different chairs
→ everyone (depends on taken course)

Description:
→ These two modules include all those courses not embedded in other modules. Depending on the chosen courses, students get different number of credits.

Includes:
→ Compiler construction (lectures) [rec. for balanced and theory path]
– winter semester, 3 credits
→ iOS programming (lectures) [rec. for balanced and networks path]
– winter semester, 3 credits
→ Lab: Microkernel-based OS [rec. for operating systems path]
– winter semester, 6 credits
→ Paper Reading Group OS [rec. for everyone]
– every semester, 3 credits

[E13] ATSA: Advanced Topics in Systems Arch. *
[E14] ATDS: Advanced Topics in Distributed Systems *

Examples: Balanced Path

Balanced Path
- *focus*: a bit of everything
- internet, mobile, security, parallel/distributed systems
- emphasis on SW practice

Electives (with their credits):
E1-ASC (6) + E5-IS* (12) + E4-CBSE (6) + E3-DOS (6) + E6-CDS (12) + E13-ATSA** (6) = 48

Internships:
Lab SE (6) + Company (6) = 12

Summer (2nd) semester	Winter (3rd) semester
E1-ASC: Security and Cryptography II	E5-IS*: App Dev. for Mobile & Ub. Comp.
E5-IS*: Internet and Web Applications	E13-ATSA**: Compiler Construction
E4-CBSE: Component-based SW Engineering	E13-ATSA**: Paper Reading Group OS
E3-DOS: Distributed Operating Systems	Internship 1: Lab SE
E6-CDS: Found. of Con. and Distr. Systems	Internship 2: Company
E6-CDS: Lab Con. and Distr. Systems	

* E5-IS: chosen two courses – „Internet and Web Applications“ and „App. Dev. for Mobile...“
** E13-ATSA: chosen „Compiler Construction“ and „Paper Reading Group OS“ (each 3 credits)

Examples: Networks Path

Networks Path
- *focus*: Wide/Local Area Networks
- internet, sensors, security, mobile, distributed systems
- emphasis on SW practice

Electives (with their credits):
E1-ASC (6) + E5-IS* (12) + E2-WSN (6) + E3-DOS (6) + E6-CDS (12) + E13-ATSA** (6) = 48

Internships:
2x Lab on Networks (6) = 12

Summer (2nd) semester	Winter (3rd) semester
E1-ASC: Security and Cryptography II	E5-IS*: App Dev. for Mobile & Ub. Comp.
E5-IS*: Internet and Web Applications	E13-ATSA**: iOS programming
E2-WSN: Wireless Sensor Networks	E13-ATSA**: Paper Reading Group OS
E3-DOS: Distributed Operating Systems	Internship 1: Lab on Networks
E6-CDS: Found. of Con. and Distr. Systems	Internship 2: Lab on Networks
E6-CDS: Lab Con. and Distr. Systems	

* E5-IS: chosen two courses – „Internet and Web Applications“ and „App. Dev. for Mobile...“
** E13-ATSA: chosen „iOS programming“ and „Paper Reading Group OS“ (each 3 credits)

Examples: Fault Tolerance Path

Fault Tolerance Path
- *focus*: SW bugs / HW glitches
- dependable/fault tolerant systems, distributed systems, OS
- emphasis on low-level SW/HW

Electives (with their credits):
E6-CDS (12) + E7-SFT (15) + E11-PODS (9) + E3-DOS (6) + E13-ATSA* (6)
= 48

Internships:
2x Lab SE (6) = 12

Summer (2nd) semester	Winter (3rd) semester
E3-DOS: Distributed Operating Systems	E7-SFT: Lab Software Fault Tolerance
E6-CDS: Found. of Con. and Distr. Systems	E7-SFT: Seminar Software Fault Tolerance
E6-CDS: Lab Con. and Distr. Systems	E11-PODS: Principles of Depend. Systems
E7-SFT: Software Fault Tolerance	E13-ATSA*: Compiler Construction
E11-PODS: Seminar Depend. Systems	E13-ATSA*: Paper Reading Group OS
Internship 1: Lab SE	Internship 2: Lab SE

* E13-ATSA: chosen „Compiler Construction“ and „Paper Reading Group OS“ (each 3 credits)

Examples: Operating Systems Path

Operating Systems Path
- *focus*: Operating Systems (OS)
- operating (real-time, distributed) systems, parallel systems
- emphasis on low-level SW

Electives (with their credits):
E1-ASC (6) + E3-DOS (6) + E8-MOS (6) + E9-RTS (6) + E13-ATSA* (12) + E6-CDS (12) = 48

Internships:
Lab OS (6) + Company (6) = 12

Summer (2nd) semester	Winter (3rd) semester
E1-ASC: Security and Cryptography II	E8-MOS: Microkernel-based OS
E3-DOS: Distributed Operating Systems	E9-RTS: Real-Time Systems
E6-CDS: Found. of Con. and Distr. Systems	E13-ATSA*: Compiler Construction
E6-CDS: Lab Con. and Distr. Systems	E13-ATSA*: Lab Microkernel-based OS
Internship 1: Lab SE	E13-ATSA*: Paper Reading Group OS
	Internship 2: Company

* E13-ATSA: chosen „Compiler Construction“, „Lab Microkernel-based OS“ and „Paper Reading Group“ (3, 6, and 3 credits respectively)

Examples: Theory Path

Theory Path
- *focus*: SW theory
- security, software engineering, compilers, logic, real-time
- emphasis on theory/algorithms

Electives (with their credits):
E1-ASC (6) + E4-CBSE (6) + E12-FCL (9) + E9-RTS (6) + E6-CDS (12) + E13-ATSA* (3) + E3-DOS (6) = 48

Internships:
Lab SE (6) + Company (6) = 12

Summer (2nd) semester	Winter (3rd) semester
E1-ASC: Security and Cryptography II	E12-FCL: Foundations (MCL-F)
E4-CBSE: Component-based SW Engineering	E9-RTS: Real-Time Systems
E3-DOS: Distributed Operating Systems	E13-ATSA*: Compiler Construction
E6-CDS: Found. of Con. and Distr. Systems	Internship 1: Lab SE
E6-CDS: Lab Con. and Distr. Systems	Internship 2: Company

* E13-ATSA: chosen „Compiler Construction“

Internships: Labs at Systems Engineering Chair

[1] Lab: SFT (Software Fault Tolerance)
→ recommended for: ***fault tolerance path***
→ winter semester
→ C, C++, Java
→ programming/debugging task every 2 weeks
→ finding software bugs, making tests

[2] Lab: CDS (Concurrent and Distributed Systems)
→ recommended for: ***balanced path***
→ summer semester
→ C, C++, Java, Python Go, Rust, Erlang
→ a few big tasks for whole semester
→ writing concurrent, parallel programs

[3] Lab: SE (Systems Engineering)
→ recommended for: ***everyone***
→ any semester
→ any language (usually C/C++)
→ you contact a PhD student from SE...
→ ...and work for 6 months under his guidance

[1] Lab: SFT	6
[2] Lab: CDS	6
[3] Lab: SE	6
[4] Lab on Networks	6
[5] Company	6
[6] Small thesis	12

internship: 12

* Remember: For complete internship, need 12 credits

Internships: Labs at Computer Networks Chair

[4] Lab on networks
→ recommended for: ***networks path***
→ any semester
→ any language (usually Java/Python)
→ you contact a PhD student from Computer Networks...
→ ...and work for 6 months under his guidance

More info here:
http://www.inf.tu-dresden.de/index.php?node_id=2568&ln=en&lv_id=62

internship: 12

[1] Lab: SFT	6
[2] Lab: CDS	6
[3] Lab: SE	6
[4] Lab on Networks	6
[5] Company	6
[6] Small thesis	12

* Remember: For complete internship, need 12 credits

Internships: in Company

[5] Company
→ recommended for: ***everyone***
→ any semester
→ you have to find a company for internship...
→ ...and work there for 6 months
→ usually professors announce possible internships

Usual companies: SAP, Amazon Dresden

[1] Lab: SFT	6
[2] Lab: CDS	6
[3] Lab: SE	6
[4] Lab on Networks	6
[5] Company	6
[6] Small thesis	12

internship: 12

* Remember: For complete internship, need 12 credits

Internships: in Company

[6] Small thesis (Großerbeleg)
→ recommended for: ***everyone***
→ any semester
→ you contact a PhD student/professor...
→ ...and write a „small thesis“ in 6 months
→ requires a lot of work and written thesis in the end
→ but enough to close the **whole** internship

[1] Lab: SFT	6
[2] Lab: CDS	6
[3] Lab: SE	6
[4] Lab on Networks	6
[5] Company	6
[6] Small thesis	12

internship: 12

* Remember: For complete internship, need 12 credits

Important Links

- Main page for the DSE program
- Web-page with all DSE modules
- Official documents for the DSE program
- PDF with official info on DSE study regulations (only german)

- Chair of Systems Engineering
- Chair of Operating Systems
- Chair of Computer Networks
- Chair of Software Technology
- Chair of Privacy and Data Security
- Chair of Computational Logic
- Chair of Compiler Construction