

| | | | | | | | | | | |
|--|--|--------------------------------------|--------------------------------------|--------------------------------------|---|---|--|--------------------------------------|----------------|--|
| <p>Coordinator</p>  |  <p style="text-align: right;">Antti V. Räsänen (Aalto)</p> | | | | |  | | | | |
| <p>Involved institutions</p> | <p>Aalto, UPM, ASYSOL, Virginia Diodes The course is sponsored by EuMA/EuCoM, EurAAP, Dassault Systèmes</p> | | | | | | | | | |
| <p>Name of the course</p> | <p style="text-align: center;">Antenna measurements at millimetre and submillimetre wavelengths</p> | | | | <p style="text-align: center;">Type</p> | | | | | |
| | | | | | <p style="text-align: center;">M</p> | <p style="text-align: center;">D</p> | <p style="text-align: center;">A/D</p> | <p style="text-align: center;">A</p> | | |
| <p>Place</p> | <p>Aalto University School of Electrical Engineering, Dept. of Electronics and Nanoengineering Maarintie 8, Espoo</p> | | | | <p>Date: 6-10 May, 2019</p> | | | | | |
| <p>Summary (2000 words)</p> | <p>Testing of large (high-gain) satellite antennas as well as that of small integrated antennas at millimetre and submillimetre wavelengths is a difficult task. In case of large antennas, the classical far-field method has two major obstacles at mm and submm wavelengths: impractically large measurement distance and high atmospheric loss. The planar near-field scanning method has been used up to 1 THz. The applied near-field methods give useful information only on the main beam and its vicinity, because the field-sampling is typically very sparse. Reflector-based compact antenna test range (CATR) measurements have been carried out up to 500 GHz. Hologram-based CATR measurements have been carried out at 650 GHz. In case of small integrated antennas, various techniques for on-wafer measurements have been developed. This short course discusses the techniques and limitations of the various test methods, such as the planar near-field scanning and CATR as well as on-wafer measurements. Also, antenna pattern correction techniques are discussed. Lectures are accompanied by laboratory demonstrations/exercises. The participants have a choice to study a related specific topic prior to the short course, write a brief report and present that to other participants during the course.</p> <p>The lectures include the following: introduction, mm- and submm-wave instrumentation, near-field scanning, near-field to far-field transformation, compact antenna test range (CATR), CATR based on reflectors, a lens, or a hologram, construction of a hologram based CATR, quiet-zone testing and antenna testing in a CATR, antenna pattern correction techniques, testing of small integrated antennas.</p> <p>The laboratory demonstrations (exercises) include the following:</p> <ul style="list-style-type: none"> - vector measurements at 1THz - scanning of near-field – computation of the far-field pattern - antenna measurement in a hologram CATR - elimination of disturbing scatterer effect in a CATR – application of the APC method - on-wafer antenna measurement through reflection coefficient measurement | | | | | | | | | |
| <p>Structure of the course</p> | <p>Lectures</p> | <p>Experimental labs.</p> | <p>Computer exercise</p> | <p>Total</p> | <p>Credits</p> | <p>Assessment typology</p> | | | | |
| | <p>21.5</p> | <p>7</p> | <p>2</p> | <p>30.5</p> | <p>2 - 4</p> | <p>Attendance plus exercise – 2 cr special assignment - 2 cr</p> | | | | |
| <p>Teachers</p> | <p>Name</p> | | | <p>Organization</p> | | <p>Title</p> | | | | |
| | <p>Antti Räsänen</p> | | | <p>Aalto</p> | | <p>Dr, Prof.</p> | | | | |
| | <p>Zachary Taylor</p> | | | <p>Aalto</p> | | <p>Dr, Ass. Prof.</p> | | | | |
| | <p>Ville Viikari</p> | | | <p>Aalto</p> | | <p>Dr, Assoc. Prof.</p> | | | | |
| | <p>Manuel Sierra Castañer</p> | | | <p>UPM</p> | | <p>Dr, Prof.</p> | | | | |
| | <p>Thomas Crowe</p> | | | <p>Virginia Diodes</p> | | <p>Dr</p> | | | | |
| | <p>Sergiy Pivnenko</p> | | | <p>ASYSOL</p> | | <p>Dr</p> | | | | |
| | <p>Juha Ala-Laurinaho</p> | | | <p>Aalto</p> | | <p>Dr, Staff Scientist</p> | | | | |
| | <p>Juha Mallat</p> | | | <p>Aalto</p> | | <p>Dr, Senior Lecturer</p> | | | | |
| | <p>Aleksi Tamminen</p> | | | <p>Aalto</p> | | <p>Dr, Research Fellow</p> | | | | |
| | <p>Jianfang Zheng (laboratory exercise)</p> | | | <p>Aalto</p> | | <p>M.Sc.</p> | | | | |
| <p>Availability of dedicated structures</p> | <p>College rooms</p> | | <p>Dedicated Labs</p> | | <p>Classrooms</p> | | <p>Computer rooms</p> | | <p>Canteen</p> | |
| | <p>yes</p> | <p>not</p> | <p>Yes</p> | <p>not</p> | <p>yes</p> | <p>not</p> | | | | |
| | <p style="text-align: center;">■</p> | <p style="text-align: center;">■</p> | <p style="text-align: center;">■</p> | <p style="text-align: center;">■</p> | <p style="text-align: center;">■</p> | <p style="text-align: center;">■</p> | | | | |

ESoA short course: Antenna measurements at millimetre and submillimetre wavelengths

SCHEDULE:

Monday 6 May 2019: Introduction to mm- and submm-wave measurements, hall TU5

| Hour | Topic | Teacher |
|----------|--|----------------|
| 9-10 | Presentation and general introduction to antenna measurements | Antti Räisänen |
| 10-11 | Specific aspects at mm- and submm-wavelengths | Zachary Taylor |
| 11-12 | Research at Aalto University | Zachary Taylor |
| 12-13 | Lunch | |
| 13-14 | Submm-wave instrumentation | Thomas Crowe |
| 14-16.30 | Introductory lecture, laboratory demonstration: Vector measurements at 1 THz | Thomas Crowe |

Tuesday 7 May 2019: Near-field measurement, hall TU6

| Hour | Topic | Teacher |
|----------|--|-------------------------------------|
| 9-10 | Near-field measurements; general | Sergiy Pivnenko |
| 10-12 | Planar near-field scanning and transformation from near-field to far-field | Sergiy Pivnenko |
| 12-13 | Lunch | |
| 13-14 | Instrumentation aspects in near-field measurements | Juha Ala-Laurinaho |
| 14-16.30 | Laboratory & computer demonstration: Near-field measurement | Aleksi Tamminen, Juha Ala-Laurinaho |

Wednesday 8 May 2019: Compact antenna test ranges (CATR), hall TU7

| Hour | Topic | Teacher |
|----------|--|-------------------------------------|
| 9-11 | Introduction to CATR: Types, analysis and design aspects | Manuel Sierra Castañer |
| 11-12 | Antenna and RCS measurements in CATR | Manuel Sierra Castañer |
| 12-13 | Lunch | |
| 13-14 | Introduction to hologram CATR and RCS measurement in a phase-hologram CATR | Juha Mallat |
| 14-15 | Hologram CATR, QZ testing, and antenna measurement | Juha Ala-Laurinaho |
| 15-16.30 | Laboratory: Antenna measurement in a hologram CATR | Aleksi Tamminen, Juha Ala-Laurinaho |
| 17-22 | “Kyykkä”-game and dinner | |

Thursday 9 May 2019: Hologram CATR, hall TU7

| Hour | Topic | Teacher |
|----------|--|------------------------------------|
| 9-10 | Quasioptics, quasioptical measurements | Aleksi Tamminen |
| 10-11 | Measurement of small integrated antennas | Ville Viikari |
| 11-12 | Antenna range evaluation techniques | Ville Viikari |
| 12-13 | Lunch | |
| 13-14 | Computer exercise (in AS5): Elimination of disturbing scatterer effect in a CATR | Ville Viikari |
| 14-16.30 | Laboratory: On-wafer antenna measurements | Jianfang Zheng, Juha Ala-Laurinaho |

Friday 10 May 2019: Student seminar and exam, hall TU5

| Hour | Topic | Teacher |
|----------|------------------------------------|---------------------------------|
| 9-10 | Exam | Antti Räisänen |
| 10-12 | Seminar with student presentations | Zachary Taylor, Aleksi Tamminen |
| 12-13 | Lunch | |
| 13-14.30 | Conclusions and diplomas | Antti Räisänen |

Special assignment

Topics for special assignment:

- 1) Antenna measurement campaigns at frequencies above 100 GHz
- 2) On-wafer antenna measurements at mm-wavelengths
- 3) Effects of atmosphere in THz antenna testing
- 4) Mechanical problems in near-field scanning
- 5) Comparison between different near-field facilities
- 6) Horn antennas at submm-wavelengths
- 7) Antenna elements for antenna arrays at mm and submm-wavelengths
- 8) Suggest your own topic!

If a student is interested in a special assignment worth of extra ECTS points, he/she must select a topic from the list above or suggest his/her own topic to the course coordinator, and write a report of 5-15 pages (based on the available literature), and make a PowerPoint presentation of 20 minutes in the seminar on Friday, 10th of May. The report and PowerPoint presentation must be submitted to the course coordinator through email (antti.raisanen@aalto.fi) by Thursday, 2nd of May.