## 5.2 Modul Radio Frequencies

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| Modulbezeichnung | **Radio Frequencies** |
| Kürzel für Stundenplan | RF |
| Semester | 5 |
| Modulverantwortliche(r) | Prof. Dr.-Ing. Stefan Bartels |
| Dozent(in) | Prof. Dr.-Ing. Stefan Bartels / Prof. Dr.-Ing. Alfred Ebberg |
| Sprache | Englisch |
| Zuordnung zum Curriculum | Internationales Studium Elektrotechnik |
| Lehrform / SWS | Class: 3 SWS with integrated exercises, max. 30 Students per group<br>Laboratory: 1 SWS with integrated presentations held by the students, max. 3 Students per Group, max 4 groups in the lab. |
| Arbeitsaufwand | 60 h Class incl. exercises<br>40 h Preparation and evaluation afterwards of class<br>50 h Preparation and evaluation afterwards of lab plus presentation |
| Kreditpunkte | 5 |
| Voraussetzungen | All courses of semester 1 - 4 |
| Lernziele / Kompetenzen | The students will be able to design and to analyze RF-systems such as transmitters and receivers. They can calculate systems and subsystems with respect to their RF-related parameters describing noise, non-linearities or frequency-response. The Students are familiar with analog modulation techniques and they can describe modulated signals in time- and frequency-domain. They are able to design transmitters and receivers for various applications. In the laboratory they gain ability to handle RF-measurement-systems. They can analyze RF-systems and signals independently and document and present the results. They are able to independently elaborate new aspects of RF-related problems and present these problems and the related solutions. |
| Inhalt | **Introduction (Workload 5h)**<br>**Noise (Workload 15h)**<br>• Thermal Noise<br>• Noise Contributions by Complex Impedances<br>• Signal To Noise Ratio (SNR)<br>• Noise Sources in Semiconductors<br>• Noise Figure / Noise Ratio<br>• Noise Ratio of Passive Components<br>• System`s Noise Ration / Friis Formula |

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| | **Nonlinearities (Workload 15h)**<br>• Taylor Series Representation<br>• Output Spectrum<br>• 3rd Order Intercept Point IP3<br>**Transistor's Giacoletto Model (Workload 15h)**<br>**Superheterodyne Receivers (Workload 5h)**<br>**Oscillators (Workload 10h)**<br>• One Port Oscillators<br>• Two Port Oscillators<br>• Oscillator's Phase Noise<br>• Crystal Oscillator<br>• VCO<br>**Modulation (Workload 10h)**<br>• Amplitude Modulation<br>• Frequency Modulation<br>• De-Modulator's Noise Performance<br>• Sensitivity<br>**Transmission Lines (Workload 10h)**<br>• Distributed Circuit Model / Characteristic Equations<br>• Wave Propagation on TRL<br>• Reflection Coefficient<br>• Phase Velocity<br>• Standing Waves<br>**Smith Chart (Workload 12h)**<br>• Fundamentals<br>• Impedance Matching Network Design<br>**S-Parameters (Workload 3h)**<br>**Experiments in the Lab**<br>• AM/FM Spektrum Analysis (10h)<br>• Frequency Modulation (10h)<br>• QAM (10h)<br>• Up- and Down-Conversion (10h)<br><br>Presentation Topics to be determined individually (10h) |
| Literatur | • Young, Electronic Communication Techniques, Prentice Hall 2003<br>• Meinke, Gundlach, Taschenbuch der Hochfrequenztechnik, Springer 1992<br>• Mäusl, R., Analoge und digitale Modulationsverfahren, Hüthig 2004 |

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|---|---|
| | • Voges, E., Hochfrequenztechnik,<br>Verlag Moderne Industrie 2003 |
| Studien-/Prüfungsleistungen | Pr (Studienleistung): P, Ref; V (Prüfungsleistung): Klausur (90 Minuten) |