Electrical Engineering: RF & Microwave Engineering

**EERF 5305** Radio Frequency Engineering (3 semester credit hours) Introduction to generation, transmission, and radiation of electromagnetic waves. Microwave-frequency measurement techniques. Characteristics of guided-wave structures and impedance matching. Fundamentals of antennas and propagation. Prerequisite: **EE 4301** or equivalent. (3-0) Y

**EERF 6311** RF and Microwave Circuits (3 semester credit hours) Analysis and design of RF and microwave circuits. Topics include impedance matching, network theory, S-parameters, transmission line media (waveguide, coax, microstrip, stripline, coplanar waveguide, etc.) and passive component design (power dividers, couplers, switches, attenuators, phase shifters, etc.). Industry-standard microwave CAD tools will be used. Prerequisite: **EE 4368** or equivalent. (3-0) R

**EERF 6330** RF Integrated Circuit Design (3 semester credit hours) Introduction to RF and wireless systems; basic concepts of RF design: linearity, distortion, (P1dB, IIP3), sensitivity, noise figure; RF passives: Q-factors, impedance transformation, matching network; transceiver architectures: Receivers - Heterodyne, direct down-conversion, image reject receivers, direct conversion transmitter, two-step transmitter; low noise amplifier design; mixer design; oscillator design; basic architectures of power amplifiers. Industry-standard CAD tools will be used for design projects. Prerequisite: **EE 4340**. (3-0) Y

**EERF 6351** Computational Electromagnetics (3 semester credit hours) Review of Maxwell's equations; numerical propagation of scalar waves; finite-difference time-domain solutions of Maxwell's equations; numerical implementations of boundary conditions; numerical stability; numerical dispersion; absorbing boundary conditions for free space and waveguides; selected applications in telecommunications, antennas, microelectronics and digital systems. Prerequisite: **EE 4301** or equivalent. (3-0) R

**EERF 6355** RF and Microwave Amplifier Design (3 semester credit hours) Design of narrow band, and broadband amplifiers. Study of stability on amplifiers. Study of noise figure, noise parameters and noise sources. Low noise amplifier design. Study of distortion on amplifiers. Introduction to power amplifiers. Microwave amplifier design in integrated circuits. Prerequisite: **EERF 6311** or equivalent. (3-0) R

**EERF 6392** Millimeter Wave Integrated Circuit Design (3 semester credit hours) Millimeter wave applications, silicon integrated circuits technology trends, passive components in silicon IC's for millimeter wave operation, Drude model for silicon substrate, parasitic modeling, NQS transistor model, High frequency limit for thermal noise, chip interface including packaging and antenna, comparison between RF and mm-wave circuits, techniques for extending circuit operation frequency (injection locking and frequency multiplication), and diode circuits including a parametric amplifier. Prerequisites: **EECT 6325** and **EERF 6311** or equivalent. (3-0) T

**EERF 6393** Microwave Power Amplifiers (3 semester credit hours) RF/Microwave transistor power amplifier (PA) applications and fundamental linear and non-linear performance objectives are studied such as: output power, efficiency, and distortion. Key amplifier classes and design topologies are studied. Students will complete CAD design projects to demonstrate mastery of relevant techniques. Prerequisite: **EERF 6311**
EERF 6330 Advanced RF Integrated Circuit Design (3 semester credit hours) Power Amplifiers, different classes of linear (A, B, AB, C) and switching power amplifiers (E, G, H), CMOS Integrated power amplifiers, High Efficiency Power Amplifiers (Doherty Power Amplifier); Phase Locked Loops: Basic concepts of PLL, Charge pumps, Type-I and Type-II PLLs, Noise in PLLs, Phase Noise, Frequency multiplication, RF Synthesizer Architectures, Frequency Dividers, Fractional-N PLLs, Delta-Sigma based PLLs, ADPLL; Advanced RF transceivers; Wideband and multiband radio design; Complete link budget analysis for wireless systems. Design project will focus on design of the entire transmitter using Agilent ADS. Prerequisite: EERF 6330. (3-0) Y

EERF 7V89 Special Topics in RF and Microwave Systems (1-6 semester credit hours) May be repeated for credit as topics vary (9 semester credit hours maximum). ([1-6]-0) R