Title of Course: RF and Antenna Engineering

Code and Credit Structure: CT425 3-0-0-3

Course Placement: Group Core Course - Communication & Signal Processing Group

Instructor: Prof. Sanjeev Gupta

Aims and Objectives:

The transmission of information data through Radio Frequency (RF) energy has become the most efficient way of communication from one point to another in present scenario. For many years, RF technology has been used in defense and satellite applications, atmospheric research, radio spectroscopy, domestic microwave ovens and many other industrial applications. Other major application areas of RF Engineering include Mobile, Radar, remote communication and Astronomy. Modern technologies like Wi-Fi, WiMax, Bluetooth, GPS, RFID, GPRS and LTE used Radio communication link to transmit/receive high speed data.

Modern society depends to a large extent on reliable and efficient communication. There is a nearly unlimited demand for more affordable, faster and advanced Radio communication technologies, indicating that there will be large industrial opportunities in the future. Smart phones, Tablets PC, Smart TVs, Internet through Wi-Fi, WiMax, and GPRS, are just a few examples of today's radio communication systems that constantly improve in functionality, performance and cost. In addition, a growing number of concepts and technologies are emerging which will significantly improve areas such as healthcare, safety and security of people, the efficiency of industry and comfort of our homes.

This rapid progress in RF and microwave electronics has created an increasing demand for such a course. The course is intended for the students specializing in Communication and Electronics streams.

The objective of this course is to make student sufficiently well acquainted with the principles of Electromagnetic/RF/Microwave Engineering to be able to design circuits for high-frequency operation. The course aims to develop an understanding of the high frequency electronics, basic analysis techniques for RF and microwave network analysis, and fundamental principles of antenna function and characteristics.

Course Outline:

Introduction: RF Spectrum, High frequency (Radio Frequency and Microwaves) in Perspective and Applications, RF versus DC or Low AC signals, High Frequency Behaviour of Passive Components.

RF Networks: Applications of Smith Chart, Maximum Power Transfer Condition, Design of Matching Networks and Stub Matching, Single and Multi-port Networks, Symmetric and Reciprocal Networks, Scattering Parameters and Scattering Matrix.

Noise and Distortion in RF Systems: Noise Figure, Equivalent Noise Temperature, Non-linearity issues Inter-modulation Distortion (IMD), Harmonic and Inter-modulation Distortion, Gains/Losses, Signal-to-Noise Ratio, Tracking noise and signal level through a complete system. Receiver Sensitivity, Spurious-free and Blocking (Linear) Dynamic ranges.
Mixers: Properties and Characteristics: Conversion Loss/Gain, Noise Figure, RF/IF Isolation, LO/IF Isolation, Distortion, Power Consumption, Mixer Types (Single-ended, Balanced, Double-Balanced, Image Rejection).

Amplifiers & Oscillators: Amplifier Design using S-Parameters, Stability, RF Oscillators, Oscillator Phase Noise, Receiver Design, VCOs and Frequency Synthesisers, Injection-locked Oscillators,

Support Circuit Design: Frequency Multipliers, RF Switches, Attenuators, AGCs, Baluns, Power Splitters / Combiners, Directional Couplers, Phase Shifters.

Systematic Analysis of RF Transceiver System Design: Specifications, Block diagrams, Small Signal Analysis, dB Power, Link Budgets, System Design Trade-offs, Gains/Losses, Signal-to-Noise, Probability of Error, Bit Error Rate, $E_b/N_0$, Link Margin, Tracking Noise and Signal level through a complete system, Effects and Advantages of using Spread Spectrum techniques.


References:


Evaluation (tentative):

Attendance: 10%
Mid-Semester Examination: 40%
End-Semester Examination: 50%
Total marks out of 100 will be converted to a letter grade using a 10-point scale.
Program Educational Objectives (PEO):

PEO1: Analyze, evaluate, design and solve complex technical problems using various tools.
PEO2: Carry out research and innovation in the core areas like RF circuit analysis, antennas and wireless communication.
PEO3: Demonstrate the skills required in Satellite, Defence, Microwave and RF communication sectors.
PEO4: Adapt to the technological changes through lifelong learning for global acceptance.

Program Outcomes (PO):

PO1: Scholarship of Knowledge: Acquire in-depth knowledge of RF circuits and antenna design with an ability to evaluate, analyze and synthesize complex problems.
PO2: Critical Thinking: Analyze complex engineering problems to make intellectual and/or creative advances for conducting research.
PO3: Problem Solving: Conceptualize and solve engineering problems, to arrive at optimal solutions, considering public health and safety, societal and environmental factors.
PO4: Research Skill: Formulate research problem through literature survey, apply appropriate research methodologies to solve and contribute to the development of technological knowledge.
PO5: Usage of modern tools: Learn and apply modern engineering tools to solve complex engineering problems.
PO6: Collaborative and Multidisciplinary work: Contribute positively to collaborative-multidisciplinary scientific research, in order to achieve common goals.
PO7: Project Management and Finance: Manage projects efficiently in RF and antenna disciplines after consideration of financial factors.
PO8: Communication: Communicate with the engineering community regarding complex engineering activities confidently and effectively.
PO9: Life-long Learning: Ability to engage in life-long learning independently, to improve knowledge and competency.
PO10: Ethical Practices and Social Responsibility: Practice professional code of conduct, ethics of research in profession with an understanding of responsibility to contribute to the community for sustainable development of society.
PO11: Independent and Reflective Learning: Introspect critically the outcomes of one’s actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

Program Specific Criteria (PSC):

PSC1: Curriculum: The curriculum includes advanced mathematics applied to RF designs necessary to analyze and design complex RF systems, software and hardware components; Communication theory and systems.
PSC2: Faculty: The professional competence of the faculty must be in applied mathematics, electromagnetics, RF engineering and communication System design and integration.

Program Specific Outcomes (PSO):

PSO1: Analyze, design and implement sub-systems / systems for wired and wireless communication systems.
PSO2: Exhibit technical skills necessary to enter careers in design, installation, testing and operation of RF/wireless communication sub-systems/systems.