**ECET 590 Special Topics in Electrical and Computer Engineering Technology**

**(Electrical Systems, Electronics, Signal Processing, Sensors, and Instrumentation for Medical, Clinical and Healthcare Applications)**

**Spring 2012**

**Activities & Assessment**

* Weekly Study Report and briefing, 40%
* Research proposal , mid-term, 20%
* Final research report with possibly for Conference Paper presentation at, 40%
  + IEEE Medicine and Biology Society, <http://embs.org/>
  + Others

**Study and Research Topics**

1. Power Systems for Medical Applications and Related Electrical Safety

* Distribution of Electric Power
  + NEC code
  + UL
  + IEC 60601-1
  + Bed (NEMA 5-15P, NEMA 5-20P, medical grade; movable, transport patient), COT (ambulance testing, automotive testing, medical testing: vibration test, with person, crash test): (automation, testing, EMC testing – person interference, absorbing cell phone)
  + Wireless power
    - Standards
    - Wireless power consortium: QI Interface (wirelesspowerconsortium.com)
      * AC => DC => Power electronic (switching) => RF => transmit
      * 5 – 30 mW
        + => Rectified => saved on Cap => Battery => Inverter => AC
      * QI 5W to 120W wireless power
    - Max power
    - FCC
    - Medical Apps
      * UL
      * New, no standard?
      * IEC ?
* Macro-shock Hazards
  + Current I = X mA?
  + UL dictated, uA
    - Patient contact
    - User contact
    - Surface
    - Invasive
  + Pace maker?
  + Insulation of wires, material, dielectric, leakage current
  + Human body resistance couple to ground
* Micro-shock Hazards
  + Combined with Macro, different types of devices
  + IEC60601 - diagrams
* Electrical Safety Codes and Standards
* Best Practices to Protect Against Shock
  + Warning signs – user manuals
  + System built-in?
  + Excellent grounding
  + Sensor => High Impedance
    - Body mass (measure from left feet => right foot): signal monitoring
* Power Distribution Subsystem Protection
  + Circuit breaker
  + Medical equipment
  + Power monitoring (current limit; over load, over current protection)
  + Switching mode power system (resist brown-out, overvoltage): 80 v – 260 v, 50 Hz to 60 Hz
* Equipment Design and Protection
  + IEC60601
* Electrical Safety Analyzers
  + Insulation (Mega Ohm meter)
  + Dielectric Meter
  + Grounding Z meter
  + Functional test
  + EMC test
  + Radiated and conducted emission testing
* Testing Electrical System
* Tests of Electrical Appliances
* Power supply system reliability
  + Standard?
  + 60601
  + Medical grade power supply
  + Hospital backup power
    - UPS
    - Modified sine wave (power transformer, Harmonics)
    - Generator – pure sine wave

Risk analysis of ? all parts of medical equipment

* Instruction
* Components
* Functions
* Standard for Risk Analysis
* ISO 14971 – Application of Risk Management to Medical Devices
* Risk Assessment Technique – ISO 31010

1. Power Electronics for Medical Applications

* Diode
* Transistor
* FET
* IGBT
* Others

1. Analog Electronics and Analog Signal Processing for Medical Applications
   * Systems (1st, 2nd order systems)
   * Amplifiers (Inverting, Noninverting, Differential amplifiers, comparators)
   * Frequency Responses
   * Filters (Low pass, high pass, others)
   * Timers
   * A/D
   * D/A
   * Computer Hardware/Software
   * Display devices
   * Record devices
2. Sensors for Medical Applications
3. Bio and Medical Instrumentation

EMC Compatability

Tera Hetz => Human body (full image scanner, see bones and internal organs)

References

* **IEEE spectrum**
* **IEEE transactions on information technology in biomedicine**
* **IEEE engineering in medicine and biology magazine**
* **IEEE instrumentation & measurement magazine**
* **IEEE power & energy magazine**
* **IEEE signal processing magazine**
* **IEEE transactions on biomedical circuits and systems**
* **IEEE transactions on biomedical engineering**
* **IEEE transactions on neural systems and rehabilitation engineering**
* **IEEE transactions on dielectrics and electrical insulation**
* **IEEE transactions on energy conversion**
* **IEEE transactions on instrumentation and measurement**
* **IEEE transactions on man-machine systems**
* **IEEE transactions on medical imaging**
* **IEEE transactions on visualization and computer graphics**
* **IEEE transactions on multimedia**
* **IEEE transactions on nanobioscience**
* **IEEE transactions on nanotechnology**
* **IEEE transactions on power delivery**
* **IEEE wireless communications**
* **IEEE transactions on ultrasonics, ferroelectrics, and frequency control**