Theoretical Health Physics Examination Topics

I. Stochastic processes
   a. Independent events
   b. Poisson statistics
   c. Theoretical resolution of energy deposition
   d. Deviation from Poisson statistics – Fano factor

II. Nuclear physics basics
   a. Field descriptions
   b. Interaction of radiation with matter and interaction rates
      i. Production of annihilation radiation, Bremsstrahlung, and Auger electrons
   c. Radioactive decay
      i. Half-life, mean life, decay constant, activity
      ii. Simple decay
      iii. Composite decay
      iv. Serial decay
      v. Activation /decay relations
   d. Nuclear decay schemes
   e. Shielding and radiation attenuation

III. Ionizing radiation
   a. Types and sources
   b. Characteristics
   c. Field quantities
   d. Interaction with matter
      i. Ionization, excitation, W-value
      ii. Range, CSDA range, density thickness, mean-free path
      iii. Stopping power, linear energy transfer, lineal energy transfer
      iv. Compton effect, photoelectric effect, pair production
      v. Attenuation coefficients
      vi. Rayleigh scattering
      vii. Photonuclear interactions
   e. Quantities describing interactions
      viii. Kerma
      ix. Absorbed dose
      x. Exposure

IV. Radiation measurement and counting
   a. Theory
   b. Gas-filled detectors
   c. Scintillation detectors
   d. Semiconductor detectors
   e. Special detectors

V. Dosimetry
   a. Fundamentals and concepts
   b. Cavity theory
      i. Bragg-Gray theory
      ii. Spencer cavity theory
      iii. Burlin cavity theory
      iv. Fano theorem
      v. Other cavity theories
      vi. Interfaces
   c. Radiation equilibrium
   d. Charged particle equilibrium
      i. Distributed sources
      ii. Indirectly ionizing radiation
      iii. Failure of CPE
   e. Transient charged particle equilibrium
   f. Active and passive dosimeters
   g. Mixed field measurements
   h. Calibration
   i. Quantities in radiation protection
      i. Quality factor (radiation weighting factor)
      ii. Tissue weighting factors
      iii. Dose equivalent (equivalent dose)
      iv. Effective dose equivalent (effective dose)

VI. Radiobiology and biological effects
   a. Relative biological effectiveness
   b. Cell type and radiation sensitivity
   c. Molecular processes
      i. Direct action
      ii. Indirect action
      iii. Oxygen effect
   d. DNA damage
   e. Repair and misrepair

VII. Models of radiation damage
   a. Single hit models
   b. Multi-hit models
   c. Multi-target models
   d. Survival curves
   e. Influence of radiation quality
   f. Stochastic effects
   g. Deterministic effects
   h. Relative and absolute risk models
   i. Weaknesses and uncertainties

VIII. Radioactivity transport and pathways
- a. Routes of entry into the body
- b. Routes of elimination from the body
- c. Biological half-times
- d. Systemic and metabolic models
- e. Bioaccumulation factors

IX. Other topics
- a. X-ray machines and accelerators
- b. Food irradiation
- c. Neutron radiography
- d. Radiological terrorism
- e. Radioactive waste management
- f. Space radiation
- g. Aerosol physics – physical elements and determinants of exposure
    - i. Deposition of particles as a function of size: diffusion, impaction
        1. environmental deposition
        2. internal deposition
    - ii. How radioactivity associates with particles
        1. dispersion as particles of bulk radioactive materials
        2. deposition of atomic or molecular radioactive species on pre-existing particles
        3. formation of particles about atomic or molecular radioactive species
    - iii. Environmental influences on carriers of radioactivity
        1. humidity as a cause of size change – condensation or evaporation
        2. background aerosols as scavengers of airborne radioactivity for either beneficial purposes or otherwise