I. Diagnostic Procedures (~35%) [70 items]

II. Instrumentation/Quality Control (~30%) [60 items]

III. Radiation Protection (~10%) [20 items]

IV. Radiopharmaceuticals (~25%) [50 items]

I. DIAGNOSTIC PROCEDURES (~35%) [70 items]

A. Administration of Radiopharmaceuticals, Pharmaceuticals, and Interventional Medications

1. Concepts of administration including indications, contraindications, adverse reactions, medication interactions, routes of administration and pediatric considerations
   a. Indications
   b. Contraindications
   c. Adverse reactions
   d. Medication interactions
   e. Dosing and route of administration
   f. Pediatric considerations
   g. Routes of administration

2. Dosage determination, preparation and administration
   a. Units – calculations and conversion
   b. Verify correct radiopharmaceutical for exam
   c. Calculation of radiopharmaceutical/pharmaceutical dose
   d. Calculation of pediatric dose
   e. Volume determination
   f. Dose determination according to scan mode and equipment type
   g. Preparation for administration
   h. Assay in dose calibrator
   i. Radiopharmaceutical labeling
   j. Administration techniques
      i. Oral
      ii. Intravenous
   k. Residual dose measurement

3. Pharmaceuticals and Interventional Medications
   a. ACE inhibitors
   b. Acetylcholine antagonists
c. Adenosine agonists
d. Adenosine Deaminase Inhibitor
e. Anxiolytics/Hypnotics/Sedatives
   i. Barbiturates
   ii. Benzodiazepines
   iii. Benzodiazepam antagonist
   iv. Non-Benzo, benzo receptor agonist
f. Antiarrhythmics (by class)
   i. Lidocaine (C1)
   ii. Beta Blockers (C2)
   iii. Amiodarone (C3)
   iv. Calcium Channel Blockers (C4)
   v. Digoxin (other)
   vi. Adenosine (other)
g. Anticoagulants
   i. Acetylsalicylic acid
   ii. Heparin
h. Antiseizure
i. Beta Agonist
   i. Dobutamine
j. Cholesterol-lowering drugs
k. Diabetic medications
l. Diuretics
   i. Acetazolamide- cerebral perfusion
   ii. Furosemide
m. Glucose
n. Growth stimulation hormone factor
o. Hematopoetins
p. Hyperinsulinemic-euglycemic clamp
q. Insulin
r. Methylxanthines
   i. caffeine, aminophylline, theophylline
s. Nitrates
t. Steroids

4. Principles and administration of contrast media
   a. Oral
   b. Non-ionic
   c. Ionic

5. Factors affecting distribution of PET radiopharmaceuticals
   a. Disease states
      i. Ictal vs. inter-ictal
      ii. Infectious processes
      iii. Inflammatory disease
      iv. Mild cognitive impairment
   b. Exercise
   c. Hydration
   d. Medicinal Factors
      i. Chemotherapy
      ii. Granulocyte colony-stimulating factors
      iii. Erythropoiesis stimulating agents
      iv. Psychotropics
      v. Metformin
vi. Steroids
vii. SSRIs
viii. TPN/IV with dextrose or lactated ringers
ix. Laxatives
x. Serum insulin level/insulin pump
xi. Fluoroquinolones
e. Muscle tension
f. Radiation therapy/Radiation treatment
g. Serum glucose level
h. Stimulation
i. Surgery/biopsy
j. Surgical variants
k. Environment/Temperature

6. Emergency care
   a. CPR
   b. Contrast reactions
   c. Diabetic complications
   d. Emergency medications
   e. Hypoglycemia

B. Gated Procedures (Cardiac and Respiratory)
   1. Equipment
   2. Lead placement
   3. Sources of error
      a. Patient
      b. Equipment
      c. User
   4. Respiratory gating techniques

C. Imaging Techniques:
   1. Cardiology:
      a. History and assessment
      b. Clinical Indications and contraindications
      c. Patient preparation/instructions
         i. pre-arrival
         ii. pre-injection
         iii. post-injection
         iv. post-procedure—discharge instructions
      d. ECG's
         i. Patient preparation, electrode placement
         ii. Rate calculation
         iii. Normal and abnormal rhythms
      e. Exercise
      f. Uptake period
      g. Patient positioning
         i. Low dose scout
         ii. Transmission
         iii. Anatomical markers
      h. Anatomy/Physiology/Imaging techniques
         i. Myocardial Perfusion Imaging
         ii. Myocardial Viability
         ii. Myocardial Sarcoidosis
iv. Myocardial oxygen consumption/hypoxic imaging

2. Neurology:
   a. History and assessment
   b. Indications and contraindications
   c. Patient preparation/instructions
      i. pre-arrival
      ii. pre-injection
      iii. post-injection
      iv. post-procedure – discharge instructions
   d. Uptake time
   e. EEG monitoring
      i. Patient preparation
      ii. Seizure activity patterns
   f. Patient positioning
   g. Anatomy/physiology/Imaging Techniques
      i. Alzheimer
      ii. Brain Tumors
      iii. Dementia
      iv. Epileptic seizures
      v. Movement disorders
      vi. Other indications

3. Oncology:
   a. History and assessment
   b. Clinical indications and contraindications
   c. Patient preparation/instructions
      i. pre-arrival
      ii. pre-injection
      iii. post-injection
      iv. post-procedure – discharge instructions
   d. Uptake time
   e. Patient positioning
      i. Arms up/down
      ii. Head first/feet first
   f. Anatomy/physiology/Imaging techniques
      i. Oncologic Indication
      ii. Dosimetry exams for Theranostics/Therapy Planning

4. Inflammation/Infection:
   a. History and assessment
   b. Clinical indications and contraindications
   c. Patient preparation/instructions
      i. pre-arrival
      ii. pre-injection
      iii. post-injection
      iv. post-procedure – discharge instructions
   d. Uptake time
   e. Patient positioning
   f. Anatomy/physiology/Imaging techniques

5. Acquisition modes
   a. 2D
   b. 3D
   c. Time of Flight
   d. Emission
e. Transmission
   i. Measured
   ii. CT
f. Single bed position
   i. Post-injection start time
   ii. Scan duration
g. Dynamic imaging
   i. Framing rates
   ii. Injection sites/techniques
h. Whole body imaging
   i. Post-injection start time
   ii. Number of bed positions
   iii. Scan duration/bed
   iv. Slice overlap

II. Instrumentation/Quality Control (~30%) [60 items]

A. Survey Meter
   1. Operating principles
   2. Quality control
   3. Source selection
   4. Interpretation of QC results

B. Dose calibrator
   1. Operating principles
   2. Quality control (accuracy, linearity, geometry, constancy)
   3. Frequency of quality checks
   4. Source selection
   5. Interpretation of results

C. Well Counter
   1. Operating principles
   2. Quality control (constancy, energy FWHM, chi-square)
   3. Frequency of quality checks
   4. Source selection
   5. Interpretation of results

D. Scintillation Detector Systems
   1. Principles of scintillation detection
   2. Detector materials
      a. BGO
      b. LSO and LYSO
      c. GSO
      d. solid state detectors
   3. System types
      a. Dedicated PET
      b. Integrated PET/CT
         i. CT radiographic tube
         ii. CT Data acquisition
         iii. CT Collimation
         iv. kVp and mAs
v. CT detectors

4. Quality control
   a. Normalization
   b. Blank scan
   c. Gains (Singles)
   d. Calibration factors for quantification
   e. cross-calibration/well counter calibration
   f. Acceptance testing
   g. Scanner failure/recognition of instrumentation artifacts
      i. Detector failure
      ii. High voltage drift
      iii. Energy drift
      iv. Gain drift
      v. Power supply drift/failure
      vi. Temperature drift (cooling system failure)
      vii. Coincidence timing malfunction
      viii. Transmission source malfunction
      ix. Septa mis-positioning/alignment
      x. Imaging table failure

h. CT scanner quality control
   i. Artifact analysis
   ii. CT Laser/Alignment light
   iii. CT Number Accuracy and Noise
   iv. Tube warm up and air calibration
   v. Water phantom

5. System performance
   a. Scatter fraction
   b. Randoms fraction
   c. Noise equivalent count rate (NEC)
   d. NEMA standards and testing

E. Theory of Operation
   1. Principles of Coincidence Detection
      a. Trues
      b. Randoms
      c. Scatter
      d. Lines of response (LORs)
      e. Delayed event
      f. Coincidence timing window
   2. Image Formation and Reconstruction
      a. Sinograms
         i. 2D
         ii. 3D
         iii. Fourier rebinning
         iv. Filtered back projection (FBP)
         v. Iterative reconstruction
            a. Ordered subset expectation maximization (OSEM)
            b. Maximum likelihood expectation maximization (MLEM)
      b. Image filters/cutoff frequencies
      c. CT Image formation and data acquisition
         i. Performing localizer scans
         ii. Helical CT imaging
iii. Axial scanning

3. Data processing/corrections
   a. Normalization
   b. Decay correction
   c. Attenuation correction
      i. Calculated
      ii. Measured
      iii. Segmented
      iv. No attenuation correction
   d. Random correction
   e. Scatter correction
   f. CT image reconstruction and post-processing techniques

F. Data Analysis
1. Quantitative analysis
   a. Region of interest
   b. Time activity curves
   c. Standardized Uptake Value (SUV)
      i. Methods of calculation
      ii. Sources of error
   d. Metabolic flow rate measurement and analysis
   e. R to L count profiles and histogram
   f. Cardiac polar mapping
   g. Other
2. Image reconstruction variants

G. Basic Principles of Image Fusion/Image Registration
1. Manual
2. Mechanical
3. Automated
   a. Rigid
   b. Deformable

H. Image Artifacts
1. Pre-procedure
   a. Medications
   b. Prosthetics
   c. Therapeutic effects
   d. Exercise
2. Injection/uptake
   a. Muscle tension
   b. Injection sites/tubing
   c. Radioactive contamination
   d. Environment (temperature, noise)
3. Scanning Procedure
   a. Patient motion
   c. Bed position overlap
   d. Urinary catheter lines
   e. IV lines
   g. Filter/cutoff selection
   h. Partial volume effect
   i. Attenuation correction
j. CT
   i. Contrast
   ii. Attenuation correction
   iii. Transmission/emission (misalignment)
   iv. High Z material
   v. CT factors impacting image quality

I. Ancillary Equipment
   1. Defibrillator/Emergency cart access
   2. Dose Delivery systems
   3. EEG monitor
   4. EKG monitor
   5. Gate Box/trigger
   6. Glucose meter
   7. Intravenous infusion pump
   8. O2 saturation monitor
   9. Radiopharmaceutical generators
   10. CT contrast power injector

III. RADIATION PROTECTION (~10%) [20 items]

   A. Personal protection/monitoring
      1. Basic concepts (ALARA)
      2. Personnel protection
         a. Time
         b. Distance
         c. Shielding
            i. Patient dose
            ii. Dose calibrator
            iii. Scanning room
            iv. Waiting room
            v. Control room
            vi. Patient holding room
            vii. Waste
      3. Personnel monitoring devices (body/extremity)
      4. Regulatory requirements including appropriate signage
      5. CT Patient Dose reporting
         a. CTDI
         b. DLP

   B. Area/facilities monitoring
      1. Basic concepts
      2. Survey equipment
      3. Radiation surveys
      4. Regulatory requirements

   C. Packaging and storage of radioactive materials
      1. Inspection of incoming/outgoing materials
      2. Storage of radiopharmaceuticals
D. Records
1. Shipping of radioactive materials
2. Receipt of radioactive materials
3. Administration of radioactive materials
4. Storage of radioactive materials
5. Disposal of radioactive materials
6. Radiation surveys

E. Radioactive decontamination
1. Area
2. Personnel

F. Disposal of Radioactive Waste
1. Release to environment
2. Decay to storage
3. Incineration
4. Transfer to authorized recipient

G. Medical Events
1. Definitions
2. Reporting and notification

IV. RADIOPHARMACEUTICALS (~25%) [50 items]

A. Radiopharmaceutical Characteristics
1. Method of localization
2. Radiopharmaceutical kinetics
3. Radiopharmaceutical dosimetry
4. Radiopharmaceutical biodistribution and normal variants

B. Physical properties of radioactive materials
1. Types of emissions
2. Energies
3. Decay rate and half-life

C. Positron radionuclide principles
1. Positron decay
2. Positron energy
3. Annihilation reaction
4. Bremsstrahlung radiation
5. Decay factors
6. Exposure rates
7. Half value layer

D. Radionuclide production
1. Cyclotron
   a. Principles of operation
   b. Targetry
2. Generators – Ge-68/Ga-68, Sr-82/Rb-82
   a. Principles of operation
   b. Elution
3. Quality control
   a. Sterility
   b. pH
   c. Apyrogenicity
   d. Identity

E. Synthesis of radiopharmaceuticals
   1. Basic chemistry
   2. Synthesis modules

F. Quality control of radiopharmaceuticals
   1. Purity
   2. Stability

G. Regulatory Requirements for Radiopharmaceutical Preparation
   1. Immediate use provisions
   2. Dose pooling or splitting
   3. Aseptic competency
   4. Radiopharmaceutical Processing Environment

H. Radiopharmaceuticals
   a. C-11 Acetate
   b. C-11 Choline
   c. Cu-64 dotatate
   d. F-18 fluciclovine
   e. F-18 florbetaben
   f. F-18 florbetapir
   g. F-18 flortaucipir
   h. F-18 fluorodeoxyglucose (FDG)
   i. F-18 fluorodopa (F-Dopa)
   j. F-18 fluoroestradiol
   k. F-18 flutemetamol
   l. F-18 piflufolastat
   m. F-18 sodium fluoride
   n. Ga-68 dotatate
   o. Ga-68 dotatoc
   p. Ga-68 gozetotide (PSMA-11)
   q. N-13 ammonia
   r. Rb-82 chloride