CMPI Examination Paper III Question Bank
Specialty: Radiation Oncology Physics

(Revised June 2014)

It is not guaranteed that the questions for the CMPI exam will be from this bank alone. Please email bpaulravindran@gmail.com for any corrections.

Question bank for section II

Section I: Multiple choice questions (No question bank will be available for this section)

Section II: Definitions / Short answers

1. Define exposure
2. Define Roentgen
3. Define Absorbed Dose
4. Define Gray
5. Define KERMA
6. What is Grenz-ray therapy?
7. Write the equation for pressure and temperature correction for Cobalt 60 output calibration
8. Define linear attenuation coefficient
9. Define Mass attenuation Coefficient
10. Define atomic attenuation coefficient
11. Define electronic attenuation coefficient
12. Derive the unit for linear attenuation coefficient
13. Derive the unit for mass attenuation coefficient
14. Derive the unit for atomic attenuation coefficient
15. Derive the unit for electronic attenuation coefficient
16. Define half life
17. Define mean life
18. Write the conditions for photoelectric interaction to take place.
19. What is Compton scattering?
20. Define pair production
21. In a deep x-ray treatment bone would receive higher dose than tissue, why?
22. Write the three ways in which electrons interact with matter.

23. How does a neutron interact with matter?
24. In a neutron treatment fat would receive higher dose than tissue, why?
25. Define stopping power of a medium
26. How is electron density calculated?
27. Define mass stopping power.
28. What is the main difference between the Bragg-Gray formulation and the Spencer-Attix ionization chamber theory?
29. Calculate the number of atoms present in a cobalt -60 isotope after 13 years, if the initial number of atoms present were 10^{8}.
30. The half life of ^{125}I is 59.4 days calculate its mean life and the decay constant
31. The source in a cobalt 60 unit is 2cm in diameter, the SSD is 80 cm and the SDD is 50 cm. What is the size of the penumbra at the surface of the patient?
32. Define Bremsstrahlung radiation.
33. What are continues x-rays
34. What are characteristic x-rays
35. What is anode 'heal effect'?
36. What is internal conversion?
37. Define exposure rate constant
38. Define Specific Gamma Ray Constant
39. Write the equation for production of ^{60}Co .
40. Draw the decay scheme of ^{60}Co
41. What is the principle of electron acceleration in Betatron?
42. Compare the energy distribution of Betatron and linear accelerator.
43. Compare the dose rate of Betatron with that of linear accelerator.
44. What is the principle of electron acceleration in Microtron?
45. Where does cyclotron find use in Radiotherapy?
46. What is a D-T generator?
47. How is a standing wave setup in a Linac wave guide?
48. Name two issues in using a scattering foil to obtain useful electron beam.
49. Why is a scattering foil used in a linear accelerator?
50. What is a flattening filter?
51. What are the types of wave guides used in linear accelerator?
52. What are the types of bending magnets used in a Medical Linear accelerator?.
53. Name the types of source ON / OFF mechanisms in Cobalt units.

54. What are the frequency ranges for microwaves of L, X and S band respectively?
55. Which radiofrequency is used in Medical Linacs and in which RF band it belongs to?
56. What is the length of waveguide for 4MeV and for 25 MeV linear accelerator?
57. Where X band Linacs are used and why?
58. What are the types of RF power sources in a Linear accelerator?
59. What is the difference between a traveling waveguide and standing waveguide with respect to the RF supply?
60. Why standing waveguide is shorter than the traveling waveguide?
61. What are the two types of electron guns used in a linear accelerator?
62. Write the differences between klystron and magnetron.
63. What is a Pulsed Modulator in a linear accelerator?
64. What is the function of steering coils and where is it located in a linear accelerator?
65. What is the role of focusing coil in a linear accelerator?
66. What are the three types of bending magnets?
67. Name any six components seen in the head of the fifth generation linear accelerator.
68. What are the types of targets used in a medical linear accelerator?
69. What should be the consideration when designing the thickness of the x-ray target?
70. What is the function of flattening filter in a linear accelerator?
71. What material is preferred as the flattening filter?
72. What are the methods of obtaining clinical electron beams?
73. What is dose monitoring system in a linear accelerator?
74. What are the main requirements for monitor chambers in a linear accelerator?
75. Why are sealed ion chambers used as dose monitor chambers in linear accelerators?
76. What is effective atomic number ? write the equation to determine the same.
77. Why a the unit of MV is used to denote the energy X-rays instead of MeV?
78. Name the three basic quantities to be measured on a linac for commissioning a Treatment Planning System.
79. How is high energy beam quality described as per IAEA protocol?
80. How is high energy beam quality described as per TG 51 protocol?

81. Define percentage depth dose (PDD).
82. What are the parameters that influence the depth of dose maximum (D_{max})?
83. Name the parameters that influence the percentage depth dose.
84. Define Tissue Maximum Ratio (TMR).
85. Name the parameters that influence the Tissue Maximum Ratio.
86. Define Tissue Phantom Ratio (TPR).
87. What are the parameters that influence the Tissue Phantom Ratio (TPR)?
88. For a constant depth, field size and energy, the percentage depth dose increases with SSD, why?
89. Why TAR and TMR are independent of SSD?
90. Define Radiological penumbra.
91. How is the field size defined in a clinical x-ray beam?
92. What are the parameters used to quantify field uniformity?
93. Write the equation used to determine the field flatness.
94. What are termed as 'horns' in dose profile of a linear accelerator and why are they seen?
95. Write the equation to determine symmetry of a beam
96. What are beam modifiers of a clinical photon beam?
97. Define wedge angle.
98. What is a dynamic / Virtual wedge?
99. What is a low melting point alloy and what are its components?
100. Define relative dose factor or the output factors.
101. What are the beams shaping devices used to shape clinical photon beams?
102. Name the beam directional devices used.
103. What are the parameters used to describe the depth dose of a clinical electron beam?
104. Define practical range of a clinical electron beam. What is the practical range of a 12 MeV electron beam.
105. Define therapeutic range of a clinical electron beam. What will be the approximate therapeutic range for 9MeV beam?
106. Write the equation to determine the most probable electron energy E_p of a clinical electron beam and explain the parameters in the equation.
107. Determine the E_p of a clinical electron beam with R_p of 6 cm.
108. Write the equation to determine the mean energy of a clinical electron beam.

109. Determine the mean energy of a clinical electron beam that has R_{50} = 5.2cm
110. Calculate the practical range and R_{50} of a 12 MeV beam.
111. What is bremsstrahlung tail in a clinical electron beam?
112. What contribute to these bremsstrahlung tails in a clinical electron beam?
113. How can you measure the bremsstrahlung contamination in a clinical electron beam?
114. Name four different types of electronic portal imaging devices.
115. What is meant by quantum efficiency of an imaging detector?
116. Write two issues in using film for dosimetry for absolute dosimetry.
117. Define optical density.
118. What is gamma of a film characteristic curve?
119. Write two methods which could be used for absolute dosimetry and explain why?
120. What does the term 'glow curve' mean?
121. What is thermo-luminescence?
122. What are the two branches of Gel Dosimetry?
123. What are the methods of reading dose in a Gel matrix?
124. Explain absolute dosimetry and relative dosimetry?
125. Why calorimetry is not practical in a clinical setup?
126. Why air is chosen as the medium in ion chamber?
127. What is an isocentric treatment?
128. What is an SSD treatment?
129. Define Gross Tumor Volume (GTV)
130. Define Clinical Target Volume (CTV)
131. Define Planning Target Volume (PTV)
132. What is an isodose curve?
133. What is an isodose chart?
134. What is hinge angle?
135. Write the equation to select wedge angle from hinge angle?
136. How would you calculate the minimum distance required between two adjacent photon beams to avoid hot spot?
137. A radiation beam passes thro 3 cm tissue, 2cm of bone and 5 cm of lung before reaching the prescription point; calculate the equivalent depth (path length)? (assume density of 0.3 for lung and 1.6 for bone).
138. What is a bolus?
139. Write the equation to determine the CT number (Hounsfield unit) and mention the CT number for air, bone and tissue in x-ray CT.

140. Give a clinical situation where megavoltage CT will be useful and explain how?
141. Why MR images are not used for obtaining dose distribution in a TPS?
142. What is an isocentre of a external beam treatment unit?
143. What is a dose volume histogram DVH) ?
144. What are the types of DVHs?
145. What is meant by DICOM format?
146. What is DICOM RT format?
147. How is Helical Tomotherapy different from Tomotherapy?
148. What are the requirements to deliver Intensity modulated radiotherapy (IMRT)?
149. What are the methods of delivering stereotactic Radiosurgery (SRS)?
150. What is a multi-leaf collimator (MLC)
151. Name three advantages of multileaf collimator (MLC) over conformal blocks
152. What types of leafs are used to reduce penumbra in MLC?
153. What are the basic methods of delivering IMRT?
154. What is step and shoot IMRT?
155. What is gated Radiotherapy?
156. What is DIBH technique?
157. What are the differences between SRS and SRT?
158. Define 'small field' in radiation dosimetry.
159. What is Bragg peak Radiosurgery?
160. How many ^{60}Co sources are used in Gamma Knife unit and what is the total activity of the ^{60}Co sources?
161. What are the methods of delivering TBI?
162. What are the diseases treated with TBI?
163. What is the clinical purpose of Total Body Irradiation?
164. What is the purpose of beam spoiler used in certain methods of TBI delivery?
165. What is the dosimetric aim of TBI delivery?
166. What is TSET and why is that used?
167. What are the methods of delivering TSET?
168. What is McGill rotational TSET technique?
169. What is the purpose of a Perspex sheet used in TSET technique?
170. What is the desirable electron energy for TSET technique and how is it achieved?
171. What is Intra-operative radiation therapy (IORT)?

172. What sources of radiation are used for Intra-operative radiation therapy (IORT)
173. What are the advantages of heavy charged particles over x or gamma ray beam in radiation therapy?
174. How is Bragg Peak formed by the heavy charged particle?
175. Why Bragg peak not observed in electron beam?
176. What is a depth profiling or range modulation in proton beams?
177. What are the corrections applied for excess tissue or lack of tissue due to surface irregularity?
178. What is mg Ra equivalent?
179. Calculate the mg Ra equivalent of 10 mCi of ^{192}Ir .
180. Define air Kerma Strength?
181. In what unit Air –kerma strength is expressed?
182. Calculate the Air-kerma strength of 10mCi of ^{192}Ir source.
183. What is radial dose function?
184. What is dose rate constant?
185. Define Geometric Factor G(r,θ).
186. What is Anisotropy factor $\varphi_{an}(r)$ or constant φ_{an}?
187. How is ^{125}I produced? Write the equation.
188. What are the desirable characteristics of an ideal brachytherapy source for temporary implant?
189. What are the desirable characteristics of an ideal brachytherapy source for permanent implant?
190. Name three sources used for permanent implant.
191. What is TRUS?
192. Define low dose rate and high dose rate brachytherapy
193. What isotopes are considered as radium substitutes & why?
194. Which isotope is used in ophthalmic applicators and why?
195. Define point A in Gynecological Brachytherapy?
196. What is point B in Gynecological Brachytherapy?
197. Give the typical Manchester loading in Gynecological Brachytherapy.
198. What is basal point in single plane implant?
199. What is basal dose?
200. What is the reference isodose in Paris technique/
201. What are the methods of source localization in Brachytherapy using simulator?
202. Which neutron source is used in Brachytherapy? Mention its half life.

203. What isotopes are used for HDR brachytherapy? and mention the initial activity of the sources when loaded on the HDR unit in each case.
204. What is PDR in brachytherapy? and what is its advantage?
205. What is hyperthermia?
206. Give the reaction used in Boron Neutron Capture therapy (BNCT).
207. What is photodynamic therapy (PDT)?
208. Mention two advantages of Carbon Ion therapy over proton therapy?
209. What is hadron therapy? Give two examples
210. What is Spread out Bragg peak and how could that be obtained?
211. What is Range Modulation?

Question bank for section III & IV (5 and 10 marks)

The marks for each question is give in brackets, [5/10] denotes that it could be either for 5 marks or 10 marks questions

1. What is radioactive equilibrium and what are their types? Mention one isotope used in Brachytherapy that benefits from this concept. [5]
2. What is Bremsstrahlung and how is it different from characteristic radiation? [5]
3. Draw the graph for energy distribution of bremsstrahlung radiation with and without filters and show the characteristic radiation. [5]
4. Bring out the differences between superficial and orthovoltage units and the treatments. [5]
5. What is Deep x-ray therapy and what are its advantages and drawbacks? [5]
6. Draw a neat cross sectional diagram of a magnetron and explain its function. [5/10]
7. Draw and explain two different methods of source movement mechanism in ^{60}Co external beam units [5/10]
8. The RMM of a cobalt unit is 150, Calculate the activity of the ^{60}Co unit and the approximate out put at 80cm. [5]
9. a) How is ^{60}Co isotope produced? b) draw the decay scheme of the ^{60}Co isotope [5]
10. a) Describe the shutter error associated with the timer on Cobalt and x-ray machines. b) Explain how this error is measured c) How is it

applied in practice when setting treatment times on a Cobalt machine [5/10]

11. Draw a neat cross-sectional diagram of a two cavity klystron, label its parts and explain the function. [5/10]
12. Draw a neat labeled diagram of the beam collimation system of a conventional linear accelerator and explain the functions of various parts. [10]
13. Compare a linear accelerator and a Betatron with reasons for (i) method of acceleration of electrons (2) Energy of the x-rays produced (3) dose rate [10]
14. Mention the reasons why Betatron is not favored as a clinical electron accelerator [5]
15. Compare standing waveguide and traveling waveguide and write the advantageous of one over the other. [5]
16. Explain why thick target is used in linear accelerator. [5]
17. Explain with a diagram how 270^0 bending magnet is better than 90^o bending. [5]
18. Why low Z material is preferred for the flattening filter in a linear accelerator? [5]
19. What is a virtual source in a clinical electron beam? Explain two methods for determining the virtual source (virtual SSD) and explain which method is clinically useful and why? [5/10]
20. How does x-ray contamination of clinical electron beams happen? And which component contributes maximum to this? [5]
21. What are the techniques to produce clinical (broad) electron beam from pencil electron beam in a linear accelerator? Compare both the techniques. [5]
22. With a diagram explain extra-focal radiation [5]
23. What is effective atomic number? Calculate the effective atomic number for Air. [5]
24. Explain with diagram and equations for energy, the methods by which photons interact with matter in the energy range used in medicine. [10]
25. Which interaction is dominant in the energy range used in radiotherapy and how? [5]
26. Write the factors, that photoelectric interaction depends on [5]
27. Write the factors that Compton interaction depends on [5]
28. What is the threshold energy for pair production to happen and why [5]
29. What is annihilation radiation? and how is that produced [5]

30. Derive the equation for photon attenuation with matter and the Half value layer [5]
31. Calculate the energy of the Compton electron and the scattered Compton photon if the energy of the incident photon $h\gamma_0$ = 51.1keV [5]
32. By derivation show the condition where the Compton photon will have an energy of 0.511MeV [5]
33. a) What is attenuation coefficient? Explain, linear, mass, electronic and atomic attenuation coefficients [5/10]
34. Draw the graph for total mass attenuation coefficient for water and lead and explain relative importance of Photoelectric, coherent, Compton and pair production [10]
35. What are energy transfer coefficient and energy absorption coefficient? [5]
36. What is a thimble chamber? What are the criteria for selecting the wall material of a thimble chamber? What are the wall materials used commonly?.[5/10]
37. (a) Draw a neat diagram of a free air ionization chamber and label its parts. (b) What are the functions of the guard electrodes and guard wires?. (c) Why Roentgen cannot be measured accurately beyond 3 MeV? [5/10].
38. Mention any five desirable characteristics of a practical ion chamber [5].
39. Briefly Describe a) build up cap b) air – wall material. [5]
40. Sketch the graph showing the variation of Pulse or Current of an ion chamber / counter for various voltages applied between the electrodes. Label various regions and explain [5/10]
41. (a) What is stem effect in ion chamber measurement? Write what causes the stem effect. (b) Explain how stem correction can be applied (with the geometry of ion chamber measurement) [5/10]
42. (a) Draw a neat cross sectional diagram of a parallel plate chamber. What is the electrode spacing in a Parallel plate chamber? (c) Explain the advantages of using the parallel plate chamber for electron beams (d) What are its applications? [5/10]
43. Draw a neat diagram of MOS-FET detector and explain its working b) what are the important points to be considered while using MOS-FET for dosimetry? [10]
44. (a) What is polarity effect in ion chamber measurement? (b) Mention two reasons for the polarity effect. (c) Between electron beam and photon beam, in which case the polarity effect is more? (5/10)

45. a) what is a radiochromic film? Explain its advantages. Plot optical density as function of dose for a radiochromic film [5]
46. What is Thermo-luminescent dosimetry? Explain the principle with a neat sketch. Sketch a glow curve for LiF TLD [5]
47. How is TLD measured? Explain a TLD Reader with neat sketch and label the parts and explain its function. [5/10]
48. Name three TLD materials used explain its properties that make them suitable for dosimetry. Explain how you would calibrate a TL dosimeter for patient dosimetry [10]
49. By calculation show that the Roentgen-to-rad conversion factor for air is 0.876 under the conditions of electronic equilibrium. [5]
50. Derive the relationship between KERMA, Exposure and absorbed dose (10)
51. With an aid of a graph explain the relationship between KERMA and absorbed dose.(5)
52. Mention how absorbed dose in air can be obtained from roentgen (b) Derive the equation to measure absorbed dose to any medium (C) What are the factors that affect the 'roentgen to rad' conversion factor i.e the 'f' factor? (d) Why 'f' factor is not defined beyond 3MeV?(5/10)
53. Calculate the exposure rate constant for ^{60}Co. Determine the exposure rate in R/min from a 5000 Ci source of ^{60}Co at a distance of 80cm. [5]
54. Derive the equation to determine the absorbed dose to any medium [5]
55. What are the corrections to be applied to the chamber reading during photon beam calibration? (b) What is k_Q? (c) How is IAEA 398 protocol is advantageous compared to IAEA 277 (5/10)
56. Mention two differences between the IAEA 398 and TG 51 Protocols (5)
57. What corrections are to be applied for environmental condition during dose measurement with ion chamber and how are they applied? [5]
58. Draw and compare the depth dose curves of ^{60}Co and 6 MV beam for 10 x 10 field size indicating the surface dose, D_{max} and depth doses at 5 and 10 cm depths(5)
59. Explain with graphs, the factors that affect the Percentage depth dose (5/10)
60. Explain with graphs, the factors that affect TMR (5)
61. With diagrams compare PDD and TMR (5)
62. With neat diagrams compare TAR and TMR (5)

63. (a) What is Scatter Air Ration (SAR)? (b) with diagram explain how the calculation for irregular field using the Clarkson's method is performed (10)
64. Derive the relationships between a) PDD and TAR, b) TAR and TMR, c) PDD and TMR with sketches [10]
65. Calculate the PDD for a depth of 10 cm for a ^{60}Co beam which is 10 x 10 cm^2 at patient surface and 130 cm SSD. [5]
66. Determine the time required to deliver 200cGy with a ^{60}Co γ ray beam at isocentre which is placed at 10cm depth in a patient, given the following data: SAD = 80 cm field size 6 x 12 cm at isocentre, dose rate free space at SAD for this field is 120cGy /min and TAR =0.681 [5].
67. What is tissue heterogeneity correction? Describe the following three methods for tissue heterogeneity corrections in dose calculations with photon beams: Tissue-air Ratio Method, power Law Tissue-air ratio Method and Equivalent Tissue-air Ratio Method [10]
68. Describe the Batho Power Law method for inhomogeneity correction [5]
69. Draw 6 MeV and 12 MeV electron beam depth dose curves and compare $R_{max,}$ $R_{85,}$ $R_{50,}$ and R_p. (5)
70. Mention four advantages of x-ray treatment simulation over megavoltage verification (5)
71. a) What is CT simulator. b) What are the advantages and disadvantages of CT simulator over conventional simulator? [5/10]
72. What is virtual simulation? b) compare CT simulator and Simulator CT. [5]
73. What is a DRR? Explain its use in Radiotherapy? [5]
74. a) What are plan evaluation tools? b) What are the types of Dose Volume Histograms and how these could be used to compare rival plans? [10]
75. Draw a typical cumulative dose volume histogram (DVH) for a planning target volume prescribed to 66 Gy (100%) with 95% dose of 63 Gy and maximum dose of 70Gy [5]
76. What is an MLC? Discuss the issues with leaf design with respect to penumbra and interleaf leakage. [5/10]
77. Where are the MLCs placed in Varian, Siemens and Elekta machines? Discuss the issues ? Compare the advantages and disadvantages of these designs. [10]
78. a) What is mMLC and where does it find application? b) How is it advantageous compared to conformal blocks [5]

79. Draw the diagram of a rounded edge MLC leaf and explain with diagram how it helps to reduce the penumbra [5]
80. Explain a double focused MLC. [5]
81. Explain the tongue & grove effect? (5)
82. Write the advantages of Dynamic / Virtual wedge over Physical wedge. [5]
83. a) What is STT with respect to Dynamic wedge? b)What is a Golden STT? c) what is the issue in measuring the beam profile of dynamic / virtual wedge with RFA and how it could be overcome? [5/10]
84. a) What is Intensity Modulation? b) What are the methods of delivering IMRT with a conventional linear accelerator? c) Compare these methods [5/10]
85. List the measurements required for commissioning a linear accelerator for Intensity Modulated Radiotherapy and write the importance of each [10]
86. What is Tomotherapy? Compare Fan beam Tomotherapy and Helical Tomotherapy. [5]
87. Draw a table comparing Standard Radiotherapy and Tomotherapy [5]
88. What is Electronic Portal Imaging Device (EPID)? b) What are the types of EPIDs c) Explain how Matrix ion chamber EPID works [5/10]
89. a) What is image registration? b) How EPID could be used clinically for setup verification? [10]
90. With a sketch describe a aSi portal imaging device [5]
91. List the measurements to be performed for commissioning a linear accelerator with mMLC for stereotactic irradiation?
92. a) What is stereotactic irradiation? b) What are the methods of delivering SRS? c) Compare stereotactic Radiosurgery and Stereotactic Radiotherapy. [5/10]
93. What is Winston-Lutz test? Why is it performed**?** [5]
94. a) What is gamma knife Radiosurgery? b) Compare it with linac based Radiosurgery [5 / 10]
95. a) What are the measurements required for commissioning cone based Radiosurgery with linac? b) What are the advantages of using mMLC for Radiosurgery? [5/10]
96. What Quality assurances are to be performed on linac before a Radiosurgery procedure? [5].
97. Explain how is Radiosurgery of AVM performed with linac based Radiosurgery? What is angiographic localization for Radiosurgery? Why is it needed? [10]

98. What is patient specific Quality assurance of an IMRT treatment? Why this has to be performed for IMRT? How this could be achieved? [5/10]
99. What are the methods of optimization for IMRT?. Explain Gradient descent method. [5]
100. Briefly describe a) inverse planning b) Simulated annealing [5/10]
101. a) What is gated radiation therapy? b) Give two clinical situations where this could be used. c) Briefly describe the two methods of gating presently used in Radiotherapy. [5/10]
102. a) What is image guided Radiation therapy? b) List the advantages of IGRT. c) List the methods of 3D image guidance [5/10]
103. a) What is cone beam Computed Tomography (CBCT) ? b) Compare kV CBCT and MV CBCT used in IGRT.
104. a) Describe the clinical indications for Total Body Irradiation (TBI) b) list the physical and clinical requirements for TBI [5]
105. List the techniques used for total body irradiation b) describe one of the methods with a neat sketch. c) What is a beam spoiler and why is that used in TBI? [10]
106. Describe the commissioning measurements required for TBI. [10]
107. a) Describe the clinical indications for Total Skin Electron Irradiation (TSEI) b) what are the physical and clinical requirements for TSEI? [5/10]
108. What are the standard TSEI techniques? b) Describe with diagram the McGill rotational TSEI technique [10]
109. List and briefly describe the commission measurements for TSEI [10]
110. What are the diseases treated with Intra operative radiotherapy (IORT)? b) What are the physical and clinical requirements for IORT? [5]
111. What is mg Radium Equivalent? b) A particular treatment is to be carried out for 5 days using 3 mg of Radium. What amount of ^{198}Au would be required if the same amount of energy is to be imparted with gold as permanent implant. [5]
112. a) What are the isotopes used in Brachytherapy? b) Give the physical properties for any three of them. [5]
113. What radioisotopes are used for permanent implants and why? [5]

114. What are the methods used for reconstructing the source position for calculation with radiographs? Explain any one method with a sketch [5]

115. Describe the rules for arrangement of radioactive sources for planner implants. Explain "mghr" and the method to calculate the treatment time using the "mghr" table. [5/10]

116. a) What is Paris Technique? b) With neat diagram explain Basal points and Basal dose for single plane and double plane implants c) What is reference isodose? [10]

117. What are point A and point B in gynecological brachytherapy? b) Explain why use of Point A is discouraged by ICRU? C) How does one report Gynecological brachytherapy as per ICRU 38? [5/10]

118. a) What are the four classifications of brachytherapy based on the dose rate? Explain each one of them [5/10]

119. a) What is remote after loading? b) What are its advantages? c) What isotopes are used in a HDR remote after-loading unit? d) Compare the merits and demerits of them as source of HDR remote after-loading unit. [5/10].

120. What are the advantages of a single stepping source? What is dwell time ? [5]

121. a) What is initial activity of a Ir^{192}Ir HDR source? b) Draw and explain the dimension of the HDR source of any one vendor. c) How would you calibrate a HDR source? [10]

122. What are the QA tests to be performed for a HDR remote after loading unit? [10]

123. a. What is optimization in brachytherapy?
b. What are the methods of optimization? & explain them [5]

124. a. Define air kerma strength? Define other factors introduced in TG43?
b. Explain each one of them with equation. [5/10]

125. Describe the following techniques and give clinical situation where these techniques are useful (a) Hyperthermia (b) Monoclonal antibodies (c) Photodynamic Therapy [10]

126. Draw the dose vs depth curve of an infinitely wide beam of 250 MeV protons. (b) What is range modulation of Proton beams? Explain the methods to perform range modulation of proton beams. [5/10]

127. What is Spread out bragg peak? Draw and compare the depth dose curve of a 15MV photons and a 140 mm range modulated Proton beam. [5]
128. Explain the methods used for obtaining broad proton / carbon ion beams [10]

129. State the advantage of Neutron therapy? How is fast Neutron produced? [5]
130. (a) What is Boron Neutron Capture therapy? (b)Give the equation for BNCT? [5]
131. (a) What is carbon ion therapy? Why is it preferred over other heavy ion treatments?
132. What are the clinical advantages of of heavy ion therapy over photon therapy. [5]