SO214
Chapter #4 Equations Quiz

ANSWER KEY

1. **What is the pulse duration for the following frequencies if each system has a 5 cycle pulse? (3 pts)**

   There are two methods for performing this calculation.

   Method 1 – Calculate the period for each frequency then multiply that period by the # of cycles/pulse

   Method 2 – This is the easier method for this particular question because you are given all of the information in the question. Divide the number of cycles by the frequency.

   2 MHz

   Method 1 – Period (μs) = 1 / 2 MHz = .5 μs so Pulse Duration (μs) = 0.5 μs x 5 cycles = 2.5 μs

   Method 2 – Pulse Duration (μs) = 5 cycles / 2 MHz = 2.5 μs

   5 MHz

   Method 1 – Period (μs) = 1 / 5 MHz = 0.2 μs so Pulse Duration (μs) = 0.2 μs x 5 cycles = 1.0 μs

   Method 2 – Pulse Duration (μs) = 5 cycles / 5 MHz = 1 μs

   8 MHz

   Method 1 – Period (μs) = 1 / 8 MHz = 0.125 μs so Pulse Duration (μs) = 0.125 x 5 cycles = 0.625 μs

   Method 2 – Pulse Duration (μs) = 5 cycles / 8 MHz = 0.625 μs

2. **What is the SPL for the following frequencies if each system has a 4 cycle pulse? (3 pts)**

   Spatial Pulse Length (SPL) (mm) =# of cycles/pulse x wavelength (mm)

   In this question, you are told the # of cycles /pulse (4) so you need to determine the wavelength to determine the SPL. The equation for wavelength in soft tissue is

   wavelength (mm) = 1.54 mm/μs / Frequency (MHz) so you need to determine the wavelength for each frequency to calculate the SPL

   3 MHz

   Wavelength = 1.54 (mm/μs) / 3 MHz = 0.513 mm

   SPL (mm) = 0.513 mm x 4 cycles = 2.05 mm

   4 MHz

   Wavelength = 1.54 (mm/μs) / 4 MHz = 0.385 mm

   SPL (mm) = 0.385 mm x 4 cycles = 1.54 mm

   10 MHz

   Wavelength = 1.54 (mm/μs) / 10 MHz = 0.154 mm

   SPL (mm) = 0.154 mm x 4 cycles = 0.616 mm

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3. **Write the PRP and PRF for the following systems. (4 pts)**
   Note: Most of the information about the systems is not relevant for answering this question. There are two methods you could use to answer this question.
   Method 1 – This method provides a more accurate number for PRF.
   You need to know that in soft tissue, sound has a round trip time of 13 μs/cm. This information allows you to calculate the PRP by multiplying the imaging depth (cm) by 13 μs. After determining the PRP (μs) you could calculate the PRF (MHz) via 1 / PRP (μs) Since PRF is usually stated in Hz, you could then convert PRF from MHz to Hz by moving the decimal point 6 places to the right.
   Method 2 – This method provides an estimate for PRF which is usually good enough for boards.
   You could approximate the PRF in Hertz via the following equation
   ~PRF (Hz) = 77,000 / Imaging depth (cm)
   Then you can determine the PRP in seconds by determining the reciprocal of the PRF in Hertz. Since PRP is usually stated in μs you would again shift the decimal point 6 places to the right.
   5 MHz transducer with 6 cycles/pulse and a max imaging depth of 10 cm
   Method 1 – PRP (μs) = 13 μs x 10 cm = 130 μs so PRF = 1 / 130 μs = 0.007692 MHz = 7692 Hz
   Method 2 – PRF (Hz) = 77,000 / 10 cm = 7,700 Hz so PRP (s) = 1 / 7,700 Hz = 0.000129 s = 129 μs
   3 MHz Transducer with 3 cycles/pulse and a max imaging depth of 3 cm
   Method 1 - PRP (μs) = 13 μs x 3 cm = 39 μs so PRF = 1 / 39 μs = 0.025641 MHz = 25,641 Hz
   Method 2 – PRF (Hz) = 77,000 / 3 cm = 25,667 Hz so PRP (s) = 1 / 25,667 Hz = 0.000038 s = 38 μs

4. **Write the duty factor for the following systems. Include the proper units. (4 pts)**
   Duty Factor is calculated via the following equation - DF (%) = (PD (μs) / PRP (μs)) x 100
   In these examples you are given the PRP so you need to determine the pulse duration. The methods for accomplishing this are explained under question 1 so here we go.
   10 MHz transducer with 5 cycles/pulse and a PRP of 130 μs
   Pulse duration (μs) = 5 cycles / 10 Mhz = 0.5 μs
   Duty Factor (%) = (0.5 μs / 130 μs) x 100 = .385%
   2 MHz transducer with 4 cycles/pulse and a PRP of 65 μs
   Pulse duration (μs) = 4 cycles / 2 Mhz = 2 μs
   Duty Factor (%) = (2 μs / 65 μs) x 100 = 3.1%