

3.2-8 A sinusoid of frequency f_0 Hz is sampled at a rate $f_s = 20$ Hz. Find the apparent frequency of the sampled signal if f_0 is

- (a) 8 Hz (b) 12 Hz
 (c) 20 Hz (d) 21 Hz
 (e) 22 Hz (f) 32 Hz

From book we can use eq 3.14:

$$f_a = \langle f_0 + F_s/2 \rangle_{F_s} - F_s/2.$$

Then,

$$f_{a,b} = \langle 12 + 10 \rangle_{20} - 10 = 2 - 10 = -8\text{Hz}$$

$$f_{a,d} = \langle 21 + 10 \rangle_{20} - 10 = 11 - 10 = 1\text{Hz}$$

$$f_{a,f} = \langle 32 + 10 \rangle_{20} - 10 = 2 - 10 = -8\text{Hz}$$

We can see this using MATLAB:

```
3 - f = [12,21,32]; % different f0 from problem
4 - f_a = [-8,1,-8];
5 - t = 0:0.001:1;
6 - t_s = 0:0.05:1; % times that get sampled
7 - for k = 1:3
8 -     subplot(3,1,k);
9 -     x = @(t) sin(2*pi*f(k).*t); % create anonymous function of frequency F0
10 -    plot(t,x(t),'k'); hold on; stem(t_s,x(t_s),'b');
11 -    title("Actual x(t) vs sampled x(t) with apparent frequency " + f_a(k) + "Hz");
12 - end
```

